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The organization designated as the International Academy of Business Disciplines is a worldwide, non-profit organization, established to foster and promote education in all of the functional and support disciplines of business.

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CONTENTS

** denotes undergraduate researcher*

WITH EYES TOWARD THE FUTURE

Vance Johnson Lewis, Oklahoma City University

Tomorrow's world approaches, so let us listen and learn,
let us explore and question and understand, let us go forth and discover the wisdom to guide
great Spaceship Earth through the uncharted seas of the future.
Ray Bradbury, 1983

Being the editor of *QRBD* is a role I never envisioned as part my future. When my friend and mentor Kaye McKinzie encouraged me to attend The International Academy of Business Disciplines in 2018, I was a bit hesitant. Save my colleagues at The University of Central Arkansas, I knew no one who would be attending and in truth, I was not particularly keen on taking on another organization. At the time, being accustomed to larger international conferences and being a rather reserved person, I envisioned yet another steady stream of business cards, handshakes, receptions, struggling to read nametags, discussions of upcoming research projects, gossip about who is leaving which school…and why, and explaining the AACSB Bridge-Program and how it is possible to have an Ed.D. and still qualify as Scholarly Academic.

--Thanks Kaye!--

Becoming a part of the IABD/*QRBD* family has turned out to be one of those lucky decisions that transforms one's life not just on the professional level but the personal as well. Academia can be a highly isolated world. Rarely do we work in office with others who share our expertise/interests as most schools only need (or can tolerate) one of us, and for the most part, we spend the bulk of our time talking to 18- to 25-year-olds who stay the same age while our calendars just keep rolling along. As academics, finding work/life balance can be challenging and conferences provide one avenue to finding fellowship and comradery to help us celebrate the victories and push through the challenges and defeats.

Not to say that other organizations do not provide the same, but IABD is an organization of present and future friends. Along with quality research presentations and workshops, one finds friends new and old catching up on families, hobbies, and simply one another. In 2020, I myself was in a serious accident which left both my personal and academic futures in jeopardy. (There was also some virus going around that put a serious crimp in how we all did things…you may have heard about it.) Although I was the newbie, I was moved by how IABD members reached out to me with encouragement, support, and most importantly, genuine concern for how I was, all the while they too were pushing through difficult times. (I really should not have been surprised knowing that many of these individuals have been together in IABD since the first conference back in 1989!) After two years online, we came physically back together in 2023, and like any good friends, it seemed like only yesterday that we had been together. IABD recognizes the importance of investing in one another beyond just the career to make sure that we continue moving forward as whole individuals.

As we look toward the future and *QRBD*'s upcoming second decade, it is appropriate to take a moment to look back and the successes we have had. First, *QRBD* has been led by one person!

Margaret Goralski served as Editor of this journal from day one, overseeing a total of 33 issues…an unheard-of dedication level in academic publications. Our current Senior Associate Editor Charles Lubbers was an author of the first article published in *QRBD*. The IABD president who made this journal possible, Paul Fadil, is still president and is still our biggest cheerleader. These are just a few of the countless examples of the supreme dedication to and affection for IABD and *QRBD* that have been shown over the past decade and will no doubt continue as we move forward.

As I begin this new phase of *QRBD's* history, our future looks bright. Authors will still find our strong outlet for their work and readers will still find outstanding articles that both inform and inspire. Still, keeping an eye on the future does require changes to keep our momentum going. Starting with this current issue, we have transitioned to using EasyChair rather than email as the means of both submitting and reviewing papers. Especially with the demands on reviewers, utilizing a centralized submission system is the best way to keep track of the review process as well as communicate with authors and reviewers alike…along with tracking our submissions for those all-important acceptance rates and analytics. Speaking of reviewers, we will in each issue spotlight a reviewer who made outstanding contributions to the current issue. Quality reviewing takes time and dedication and, while conferences often reward reviewing, journals do not…that changes today.

Another specific addition you will notice is the acknowledgement of undergraduate researchers on papers. The IABD conference is a perfect place for undergraduate students to present their research and *QRBD* will follow suit by being a permanent outlet for their work. As many accrediting boards across campus are highlighting both student impact and student research, I think it important to draw attention not only to these young scholars but also to the experienced faculty who are willing to take on the additional challenge of undergraduate research. You will find special notation on the Table of Content indicating undergraduate researchers.

As I begin my tenure as Editor, I envision some other changes to continue our journey forward. Historically, we have provided print copies of the journal at no additional cost; however, in 2023, this is an outdated practice and one that can be concluded to reallocate funds to more productive areas. I want to see active participation on our editorial review board increase and to add three associate editor positions to the board by the end of the year (I will be coming for you soon!). While we provide quality content and have a positive "Journalytics" rating by Cabells, I want to see our quality acknowledged by other services such as Elsevier's Scopus ratings. Finally, I want to publish information beyond research studies to include academic essays, book reviews, and teaching exercises. There are many avenues in which we can make an impact and I know that working together *QRBD* can have a highly impactful future in both familiar and new ways.

Much like *QRBD* itself, the articles within this issue all have an eye toward the future. First Naylar and McKinzie (2023) offer us a glimpse into how increased access to broadband internet can and does impact our society, both on the local and global scales. Next, Tinsley, Abegaz, Mady, & Yan (2023) show how banking processes can be improved through the use of Python driven automation. Finally, Boylan, Bradtke, & Hiles (2023) join the return-to-work debate by showing the benefits of working from home to the accounting industry. All of these authors have taken their forward vision to give us all information to consider as we continue to consider ways in which we can impact our society today as well as tomorrow.

As *QRBD* now looks toward its second decade, we do so with fresh pathways and opportunities. I look forward to the contributions you will make to the body of knowledge and I challenge you to push yourself to think of new ways that you can contribute. *QRBD* was started by its authors as a platform to showcase their discoveries and will continue to be a reflection of our interests, wisdom, and understanding as we travel on into our future.

REVIEWER SPOTLIGHT: *Mark A. Grimes*

One of the most essential, and thankless, roles in academia is reviewing. Quality reviewing is seldom rewarded, requires significant time commitment, and most importantly, serves as the threshold of quality publications…without quality reviewers, journals have no quality! As *QRBD* enters its second decade, a new element will be to highlight someone from the reviewer team who made significant contributions to the quality of the current issue.

For Volume 10, Issue 1, we say thank you to Mark A. Grimes, a Professor of Management and Human Resources in the AACSB-accredited College of Business and Computing at Georgia Southwestern State University where he teaches at both the undergraduate and graduate levels. He has worked in management, human resources, and training and development for two hospitals and as payroll processor. He earned his BA in Religion from Samford University, his MBA in Management from Kennesaw State University, and his DBA in Management from Argosy University. He lives in Americus, GA, with his wife and the youngest of their five children.

How did you get involved with *QRBD*?

I first learned about *QRBD* when I partnered with a colleague to submit a manuscript for consideration, and we had a really good experience with the overall process. Since that initial submission, I have partnered with colleagues for other publications. During the COVID aftermath, I partnered with two colleagues to present a paper virtually at my first experience with IABD, and then presented another paper at this past conference. It is a great conference!

Why do you consider the role of reviewing to be important?

At heart, I am a businessperson first and became an academic later in life, so research and publishing has never been a strong point or an area of passion: I do it because I have to. My experience with publishing is that the review process is very long and it sometimes takes longer to get a paper reviewed than it did to write it. I believe the role of reviewing is important because, from experience, writers have put a lot of effort into producing a paper, and they want and deserve timely feedback, even if it is sometimes not too encouraging. If I can help to provide good feedback, that helps them and it also gives me ideas for further research.

INCREASING BROADBAND ACCESS' IMPACT ON THE ECONOMY AT A LOCAL LEVEL

Randall Naylar, University of Central Arkansas

Kaye McKinzie, University of Central Arkansas

ABSTRACT

As with all technology, broadband is ever-advancing. Not only are internet speeds increasing, but internet access is becoming more readily available in both businesses and homes. Where once those living in rural areas had limited to no access to high-speed internet connections, now they have choices including cable, DSL, satellite, and low-orbit satellite. During the recent COVID lockdowns, our society not only became more reliant on the internet but also became more comfortable with using the internet in ways they had not previously. A major change was working in non-traditional business environments that are often composed of one's home. The US Federal government has recognized the importance of internet access with the Infrastructure Investment and Jobs Act which provided $65 billion for broadband. Recently there have been many stories about how broadband has impacted economic growth. (Why Broadband, n.d.) This directly drove our research. If the US is investing this much money into broadband expansion, where is the proof that it has a direct impact on the economy? We could not find any recent study at the granular level in the US. This study focused on broadband availability and unemployment from 2010 to 2018 at the county level. Some unexpected, interesting insights are provided.

Keywords: broadband, inflation, unemployment, Divisions

INTRODUCTION

There is limited publicly available data on broadband availability and its impact before 2010. This is probably because 2G was introduced in 1991, 3G in 2001, and 4G did not become available until 2006. Even with the introduction of 4G, in 2011 most of the world was still reliant on 2G & 3G. (The World, 2011) In November 2021, the US President signed the Infrastructure Investment and Jobs Act which provided $65 billion for broadband. (NTIA, 2021) This program has provided many opportunities to expand broadband, but what impact will it have? Does broadband impact unemployment?

Broadband has proven to be a breakthrough technology for many users in urban areas and rural areas (Isley & Low, 2022). With a broadband connection available, employment opportunities are often easier to find, especially with the push to a more digital market type (Hasbi, 2017). Widespread broadband availability for consumers can result in many communication opportunities and overall household income impact (Lobo et al., 2019). Broadband is seen as a contributing variable to many economic developments across the United States and the world (Lobo et al., 2019). In recent years, there has been an overall increase in consumers using broadband which contributes to many benefits to the overall economy (Lobo et al., 2019).

Unemployment rates are just one of the many economic factors that broadband can affect. Broadband allows users to connect with businesses and other users in a more efficient way (Hasbi,

2017). Literature from (Lobo et al., 2019) states that geography is no longer a barrier to entry into the employment market because broadband can allow users to apply for career opportunities from the comfort of their homes. The unemployment rate can be a main economic driver when looking at real estate, considering a new business, or even overall well-being in the area (Lobo et al., 2019). Our research takes unemployment rates and applies them to broadband availability to see just how much of an impact broadband has on unemployment rates across the United States.

Early literature has looked at broadband speed and penetration data at a less granular level. For our research, we were able to take data from the census bureau and labor statistics bureau to measure the impact of an available broadband connection on the unemployment rate at the county level. We applied granularity for this study as we dive into forty states across the United States and 1,268 counties within those states. In our research, we wanted to look at how much of an impact broadband availability has on unemployment rates at the county level. Our research focused on the period of 2012 to 2018 to give the literature an update on the most recent census bureau study on broadband availability. Our research took a similar path to how Lobo et al. (2019) conducted their research but instead of looking at broadband speed, we examined the impact of having broadband available.

This research is an extension of other work from similar studies concerning broadband and the economy conducted in many countries. We mirrored the independent variables (IVs) they used in their studies. We also mirrored their approaches using linear regression. Our paper follows a traditional format with the literature review followed by a section discussing the methodological approaches. The results describe these approaches in detail and the paper finishes with our conclusions and recommendations for future work.

LITERATURE REVIEW

Broadband

Since 2010 there have been several studies discussing how higher broadband speeds contribute to a lower unemployment rate in high-speed counties. Much of this early research has focused on broadband speed and not the impact of broadband availability by county. One such study (Lobo et al., 2019) was of the most interest to us due to its similarity, however, the data was from 2016 and prior – thus in need of an update. In this study, focusing on one specific state, Lobo found that in state-funded areas broadband adoption was higher versus other states with no funding (Lobo et al., 2019). One of the key contributions of this work was the addition of geographical variables such as state and counties when analyzing broadband's impact on unemployment.

This research by (Lobo et al., 2019) also helped provide other variables for us to consider. They found that educated counties resulted in a decline in the unemployment rate. They also found that where population density (and amount) increased there was an increase in the unemployment rate. The counties that had higher population amounts resulted in a higher unemployment rate mainly because there was more data represented in that county than in others (Lobo et al., 2019). Working age was a significant variable used in research because it gives a way to look at the geographical information on the county. Counties with an average middle age demographic had lower unemployment rates. The article showed that counties with higher income levels had a lower

unemployment rate and this variable had one of the highest significance rates in their findings. All in all, this study helped form the basis for our study.

Some other research that has been performed focuses on the relationship between broadband and the expansion of economic growth (Kolko, 2010). The study suggested that broadband might offer more benefits for rural areas helping businesses connect with larger markets outside of their service area. This paper used broadband data found on the FCC public data website and data from the US census bureau the time they studied was between 1999 and 2006. The variables that this study used in their FCC data were the average number of broadband providers, the average number of broadband providers employment weighted, percent of ZIP code tabulation areas (ZCTAs) with one or more providers, percent of ZCTAs with one or more providers employment weighted, average broadband provider count, average broadband provider count employment weighted, population growth, changes in employment, average pay, household income, change in the type of work location, employment growth area, percentage change with an increase in broadband availability, the highest share of technology inputs, the highest share in computer occupations, county level education attainment. The dependent variable (DV) they used was employment growth, but inflation had the most significant impact on their regression model. This pointed us to use the variable inflation as an impactful variable in our regression modeling.

Another study (Hatef, et al., 2021) was performed recently but they looked at residential fixed internet access subscriptions per 1,000 households. The variables included income, education, employment status, and housing quality. This was based on December 2016 subscription data from the FCC which doesn't address multiple years of change in the data. They also used data from Aunt Bertha's Social Service (now called Findhelp) which included variables such as types of available service by an organization, and the demand data had information on individual levels and healthcare workers. The most significant variable in their SLR model was employment status which told us how important employment status is when looking at broadband access (Hatef, et al., 2021).

Broadband's role in healthcare has become an important topic according to (Quinton et al., 2021). (Quinton et al., 2021) addressed the national priority for broadband to improve access to healthcare in rural communities. They took medical record data and measured broadband availability and its impact on income and educational achievements and whether there was a primary care physician in their zip code. The time they used was from March 2019 to March 2021. Since this study was conducted, we realized using broadband availability would be the most impact variable to unemployment. Their sensitive analysis performed in this study showed us that the variable broadband availability was an impactful variable to use when studying county-level data (Quinton et al., 2021).

The (Aliyev, 2021) study looked at several different descriptive models and their outcomes. It showed that the largest sample of unhappy people are in the category of jobless and they are mostly male. This gave us the idea to look at certain population groups that were impactful to unemployment. They took several different data points such as the age of males, the age of females, and if they are unemployment or unemployed. The variables ran in the descriptive model were median age, gender, educational attainment, and marital status. The variable median age was highly significant in their regression model. (Aliyev, 2021) told us that it would be relevant to study how unemployment is affected by median age.

The study (Dahliah & Nirwana, 2021) ran several statistical tests for unemployment and whether they had a positive effect on the poverty level. It showed that when unemployment is low the poverty level is important to look at over a time series plot to discover data findings. When certain business sectors have a high employment rate it showed that the poverty level was unaffected, but income levels were lower (Dahliah & Nirwana, 2021). The data they used was a sample from a public research site that had data from East Luwu from 2010 to 2020. This data was monthly data used in regression analysis and ran over ten years. Their multiple linear regression model tested poverty levels and how they affect unemployment. Since their adjusted R-squared told me how strong of a model they conducted it drove us to use a poverty variable in our study.

The study from (Barrero et al., 2021) pointed us to look at median income levels. The variables they used came from survey data they collected in May 2020. The variables collected were demographics, employment status, working, arrangements, earnings, commuting, internet access, age, gender, educational attainment, and income. The benefit of broadband can be a tough ask but that is what this research article was written to do. The article measured overall well-being when you have internet access during the pandemic. During the pandemic, mental health issues jumped significantly due to being confined to locations for long periods. The best SLR model (Barrero et al., 2021) used the variable median household income which is why we wanted to include this in our research.

Still, other research has focused on the impact of broadband speed on economic measurements such as GDP per capita, population density, price, urban population, labor force growth, telecommunication revenue growth, population growth, and the average achieved downlink speed. Rohman & Bohlin (2012) used the dependent variable GDP and ran separate regression models which measured the impact of broadband speed on economic growth in the 38 Organization for Economic Cooperation and Development (OECD) countries over the period 2008-2010. They researched the gap in broadband speed in certain of these countries around the world and how it affects developing nations. They found that broadband plays a vital part in developing nations across the world and doubling the speed will contribute to 0.3% growth.

Geographical

In their article, Whitacre & Gallardo (2020) used data from the census block and the FCC pointing us to the importance of looking at county-level detail to see rural and urban impacts. The period for the data was 2014-2018 and they were able to aggregate the data using census blocks. The variables they used were primarily the percentages of rural vs urban broadband fiber availability, percentage of the population in rural vs urban areas, broadband policies, percentage of state funds, population, income, educational attainment, and poverty rate variables.

Our Focus

There have been a variety of studies concerning broadband and the economy, but not with recent data. Rohman & Bohlin (2012) used data from 33 countries but only had data from 2008-2010. Whereas Hasbi (2017) had more current data (2010-2015), but only from France. And Whitacre & Gallardo (2020) had the most current data (2012-2018) but were only looking at the

impact of state policies on broadband availability. What is needed is a more detailed and current look at a more granular level to see if broadband availability directly impacts unemployment.

This research updates prior research in that it uses relatively current data at the US County level of specificity. Studies that were done prior only focused on a certain state within the United States or international countries. Whereas prior research has mainly focused on broadband speed and how speed impacts economic variables, this study looks at the availability of broadband. This study also takes a more narrowed focus rather than looking at the economy or the GDP, it focuses on whether broadband availability has an impact on unemployment rates throughout the US with county-level data.

In our research, we used population below the poverty line, inflation, total amount of African American population, labor force participation, and gross domestic product. These variables were shown to be significant in prior research (Isley & Low, 2022), (Bitetti, 2018), (Bohlin & Rohman, 2012), in each of the articles GDP was shown to have a positive correlation with unemployment rates. The article (Isley & Low, 2022) demonstrated that high GDP was positively correlated with lower unemployment rates. The article (Isley & Low, 2022) focused on demographics in their research as well to show the impact on unemployment. The demographic that had the most impact on unemployment was the population of African Americans. Since (Isley & Low, 2022) showed this demographic having a strong impact we included it in our model. (Adelowokan et al., 2019) saw that the population below the poverty line had an impact on unemployment. Research conducted in the article (Adelowokan et al., 2019) found that poverty caused by unemployment had a significant impact on the growth of the economy and showed a positive relationship between the two variables. All these economic and socioeconomic variables are expected to impact unemployment. In our research, we will be modeling these variables to see if we see the same impact on our dependent variable (unemployment). From Lobo's work (2019), we would hypothesize that our study would also show an inverse relationship between broadband availability and unemployment.

METHODOLOGY

We began our research on unemployment (the dependent variable) by first exploring the data, then conducting normality assumptions and other statistical tests before beginning our regression analysis. We ran multiple regressions with different groups of categorical variables before the final regression with two different sets of geographic variables and numeric variables. The addition of geographic data led us to also explore geographical patterns relating to both unemployment and our regression models.

Numerical Variables

This research begins with just considering the numerical variables to determine if our new variable (broadband) has a statistical impact on unemployment. To do this we begin with correlation analysis, followed by single linear regression (SLR), and finally multiple linear regression (MLR). SAS Studio was used for all statistical analyses in this study.

Exploratory Data Analysis

Our data came from multiple publicly available sources. (FRED, n.d; The Center, n.d.) To begin our analysis we started with exploring the data for patterns and trends as well as conducting the required normality assumptions. The main concern in this research focused on the relationship and strength of relationships between variables. This was modeled through SLR, MLR, and finally geographical mapping. Tableau was used for all mapping in this study.

Modeling

Our dependent variable (DV) was a single numerical variable (unemployment). But, we had many independent variables (IV) that were both numerical and categorical. That made this a very large problem to solve. After consulting the Advanced Research Computing website (UCLA, n.d.), we chose to analyze in steps to reduce the problem size. We began by establishing baseline models of just numerical variables using linear regression. Then we reduced the categorical variables first due to sample size and then used one-way ANOVA before building multiple linear regression (MLR) models. Our last modeling included two MLRs to see if our reduction methods were worthwhile. One MLR had all the categorical variables that survived the sample size test and one had only those categorical variables that were in each of the final MLR models for Division, State, and/or County.

One-way ANOVA

We began our analysis of the geographical categorical variables of US Census Bureau Divisions US States, and US Counties. The One-way ANOVA test let us know if any of these three variables were significant at the variable level. It also provided sample sizes and Box-Whiskers plots. This allowed us to not only eliminate any categories that failed to meet the sample size condition but also analyze the Box-Whiskers charts for differences. Once we identified categorical variables that failed the sample size tests, we recorded them as "other" and attempted a second one-way ANOVA.

Linear Regression

A multitude of regression tests was done to determine if our addition of broadband and/or geographic categorical variables helped predict unemployment and if the reduction of these variables before adding them to the final model impacted the final model. We began with just the numerical variables starting with building SLRs and then an MLR to establish our baseline models.

The next set of MLRs focused on the geographic variables. Once the geographic variables were shown to have an impact on unemployment via the one-way ANOVA, they were converted into binary variables. Those that passed the sample size text ($N \geq 30$), were put into regression models. We ran MLRs focusing on each variable independently (Division, State, County) and then combining them into one model. This last modeling was done with two models. One began with all the geographic variables that were in the models we just built. The other had more variables because it started with all the variables that passed the sample size test.

Lastly, we merged models by including the numeric variables and the geographic variables.

Pattern

The final analysis we conducted was a visual analysis of the geographical patterns. We considered Division, State, and County independently. First, we looked at the strength and direction of the correlation of these geographical impacts. Then we looked at each variable and if it was in or not in a particular MLR. Then we compared the results of the two.

RESULTS

Including all 9 of the US Census Bureau Divisions, 40 US States, and 1,268 US Counties along with our other independent variables made for a very large set of independent variables. This data covered 2012 – 2018 and was obtained from publicly available websites.

We began with modeling our numerical variables to establish a baseline. Then we reduced the categorical variables, built geographic models, and finally built models with the geographic variables and the numerical variables to determine if the addition of geographical variables helped. SAS Studio was used for all the statistical analyses.

Once the statistical analysis was complete, we mapped the modeling results to determine patterns. This was done using Tableau software.

Variables

Our new variables being added to the data from the economic study came from The Center (n.d.): Year, State, County, and percent of broadband available per household. The economic data came from FRED (n.d.): Unemployment Rate %, Percent of Population Below the Poverty Line, Median Household Income, % of People by County Population, Inflation, Population of African Americans, Total Population Per County, Labor Force Amount Per County, Median Age by County, and GDP By County. We then merged these into one data set before importing them into SAS Studio.

Our variables were tested using Bartlett's Kolmogorov-Smirnov (SAS PROC SPECTRA) test which showed small p-values (< 0.001) which drove us to reject white noise for all numerical variables. As a double-check for cointegration concerns, we also used Johanson and the Vector Error Correction model and the Dickey-Fuller tests (SAS VARMAX) showing Pr<Rho (0.001) and Pr < Tau (<0.001) for all variables.

Categorical

The categorical variables used were: Year (mode 2017), State (mode Georgia), County, and Region (mode South Atlantic).

Numerical

Most of our variables were numerical. Summary statistics are supplied in Table 1.

Table 1. Summary Statistics

	Mean	Median	Standard Deviation
Year	2016	2017	1.8
% Unemployment Rate	0.05	0.047	0.0206
% Broadband Available Per Household	0.84	0.84	0.08
Labor Force Amount Per County	92,377	33,933	241,508
Employment Amount Per County	87,175	32,090	226,225
Unemployment Amount Per County	5,202	1,700	16,418
Median Household Income	52,277	50,300	12,651
Median Age by County	40.34	40.3	5.24
% People by County Pop with Bach Degree +	23.31	21.1	9.66
% Population Below the Poverty Level by County	15.49	15	5.54
Population of African Americans Per County	22,278	2,980	69,250
Total Population Per County	184,801	73,156	478,316
Inflation	1.93	1.8	0.17
GDP By County	9,849,093	2,547,646	31,176,891

Linear Regression (LR) with just numerical variables

This research focused on adding the influence of geographical factors at the county level and broadband availability on unemployment. We begin with determining which of these 11 numerical variables (10 from prior research cited in the literature review and broadband availability) had the most influence on unemployment. We follow this with an MLR of all of these numerical variables.

Correlation

Based on the literature review we conducted, we expected to see a strong correlation between unemployment and inflation, but we found that the strongest correlation with unemployment was with the year variable. Unemployment is decreasing from 2012 to 2018 creating a negative correlation. As seen in Table 2, even the percentage of broadband per household had a stronger correlation with unemployment than inflation. As the unemployment rate is increasing, broadband and inflation are decreasing - both of which were expected. What we did not expect was to see that year was a stronger determinant than both broadband and inflation.

Table 2. Correlations

	Unemployment Rate %	p-value
Unemployment Rate %	1	
Year	-0.57478	0.0001
Percent of Population Below the Poverty Line	0.38735	0.0001
Median Household Income	-0.32587	0.0001
% Broadband Available Per Household	-0.31428	0.0001
% of People by County Population	-0.19628	0.0001
Inflation	-0.18926	0.0001
Population of African Americans	0.12855	0.0001
Total Population Per County	0.12418	0.0001
Labor Force Amount Per County	0.10876	0.0001
Median Age by County	-0.09847	0.0001
GDP By County	0.07301	0.0001

Regression

We begin with conducting SLR and then MLR. Within each table, the coefficient "b" is noted in the first numeric column indicating the regression equation. We also list the standard regression weight (beta), the squared semi-partial correlation, as well as the VIF as indicators of the models.

3 SLRs.

If we were to have run just one SLR, we would have chosen the year IV as it had the strongest correlation with the DV (unemployment). And although we did this, we felt it prudent to also analyze broadband and inflation to compare the impacts of our focus variables.

Year. This IV had the strongest correlation with the DV so it should also produce the strongest SLR. As seen in Table 3, the result was a moderate strength model as the Adj R^2 was only 0.3303.

Table 3. Year SLR

Predictor	b	95% Confidence Limits LL	UL	Pr > |t|	*beta*	sr^2	VIF
Intercept	1,332	1,286	1,377	<0.0001	0		0
Year	-0.66	-0.681	-0.635	<0.0001	-0.575	0.330	1

Fit statistic: Adj R^2 = 0.3303
Note: beta is the standard regression weight. sr2 is the squared semi-partial correlation Type I.

Broadband. Our focus variable did not have quite as strong of a relationship with the DV, but it did produce a viable model as noted in Table 4. The model strength was not as strong as the Year SLR model, but it was also a moderate model with an Adjusted R^2 of 0.0986.

Table 4. Broadband SLR

Predictor	b	95% Confidence Limits LL	95% Confidence Limits UL	Pr > |t|	*beta*	sr^2	VIF
Intercept	11.8870	11.3863	12.3877	<0.0001	0	0	0
Broadband	-8.1659	-8.7609	-7.5710	<0.0001	-0.3143	0.0988	1

Fit statistic: Adj R^2 = 0.0986
Note: beta is the standard regression weight. sr2 is the squared semi-partial correlation Type I.

Inflation. When we completed our literature review we believed that this IV would be our strongest predictor and it was not. It was worse than our new IV (broadband). When looking at the results of the SLR in Table 5, it is also evident that the model strength is weak with an Adj R^2 of 0.0357.

Table 5. Inflation SLR

Predictor	b	95% Confidence Limits LL	95% Confidence Limits UL	Pr > |t|	*beta*	sr^2	VIF
Intercept	9.4676	8.912	10.0232	<0.0001	0	0	0
Inflation	-2.2921	-2.5789	-2.0052	<0.0001	-0.1893	0.0358	1

Fit statistic: Adj R^2 = 0.0357
Note: beta is the standard regression weight. sr^2 is the squared semi-partial correlation Type I.

MLR.

Our final numerical MLR included 9 of the 11 variables that we began the model with. We used backward elimination to remove variables with an alpha of 0.05. The only two variables removed were the total population per county and the percent of broadband availability as noted in Table 6. So where we were able to create a strong model with an Adj R^2 of 0.6631, our newly introduced variable (broadband) was not a contributing IV to the model. Broadband was removed due to a large p-value, yet inflation stayed in the model with several other IVs that had a weaker correlation to the DV.

Table 6. Numerical MLR

Predictor	b	95% Confidence Limits		Pr > |t|	*beta*	sr^2	VIF
		LL	UL				
Intercept	1644.043	1598.924	1689.162	<.0001	0		0
Year	-8.17E-01	-0.8393	-0.7943	<.0001	-0.714	0.33	1.5
Labor Force Amount	1.56E-06	0	0	<.0001	0.1826	1E-04	19
Median HH Inc	4.07E-05	0	0	<.0001	0.25	0.114	4.5
Median Age County	5.62E-02	0.0486	0.0637	<.0001	0.1429	3E-04	1.4
% of People County	-6.66E-02	-0.0719	-0.0613	<.0001	-0.312	0.027	2.4
% of Population	1.80E-01	0.1694	0.1899	<.0001	0.4827	0.077	2.9
Population of AA	1.22E-06	0	0	0.0015	0.0409	6E-04	2.5
Inflation	1.16E+00	0.9457	1.3755	<.0001	0.0958	0.008	1.2
GDP By County	-1.06E-08	0	0	<.0001	-0.16	0.001	18

Fit statistic: Adj R^2 = 0.6631

Note: beta is the standard regression weight. sr^2 is the squared semi-partial correlation Type I.

At this point, we had four viable models. The strongest of these models (Table 7) was the MLR with nine of the numerical IVs. To try and improve on this, we attempted to add geographical categorical variables.

Table 7. Numerical regression results

		Adj R^2
SLR	Year	0.3303
	Broadband	0.0986
	Inflation	0.0357
MLR	9 Ivs	0.6631

Geographic Variables

We collected data from all the US Census Bureau's 9 Divisions, from 40 US states, and 1,268 counties for all 6,608 entries. Some states did not report at the county level, so we could not use that data. We first tested our data to comply with linear regression requirements. We then tested the divisions, states, and counties individually in three models before combining them.

One-way ANOVA

We began by analyzing the Division, State, and County separately to see if they statistically impact our DV. Each of these models showed that the three variables were statistically significant to predict unemployment with p <= 0.001. But the F-test does not tell us which variables in those categories are significant. Had any not been significant, then we could conclude that there was no impact, and then regression would not be needed.

Our next approach to reduce the sample size was to eliminate categories with each of the variables (Division, State, County) based on a sample size of less than 30 (for normality assumptions). For those categories with sample sizes greater than 30, we used the SAS results from the One-Way ANOVA to see if the box-whisker plots revealed any categories that were statistically significantly different than others. This test was not conclusive, but it did reduce the number of states and counties to consider as noted in Table 8 ($N \geq 30$) due to the sample sizes.

Table 8. Sample size remaining

	N >=30
Division	all 9
State	32 of 40
County	20 of 1268

Second One-Way ANOVA

We did not do this for Divisions because all of them passed the sample size tests.

We revisited the One-Way ANOVA with two approaches. The first approach recoded the State and County so that any State or County that had a small sample size was recorded at Other. The second approach consisted of making two data sub-sets where the data was reduced by eliminating (deleting rows) any State (first data sub-set) and then County (second data sub-set) where that category had a small sample size.

From this, we conducted four One-Way ANOVAs to test if State and/or County were still significant when predicting unemployment (including the other variable or deleting the other variable). They were significant in all cases with $p <= 0.001$. Indicating that regardless of how we parsed it, there were some states and counties that might influence our DV.

MLR for variable reduction

Before conducting these MLRs, we created new binary variables for each of the categories still in our model. We then ran separate MLRs for Division, State, and County. By doing this we were able to eliminate many more IVs as noted in Table 8's individual columns.

Wanting to see if we could further reduce the number of geographic variables, we ran one more MLR with the Division, State, and County IVs and were able to further reduce our IVs as noted in Table 9's last two columns. Of note is that after we eliminated for multicollinearity using the sign, VIF, and proportion of variation, we had a stronger model with the states by themselves, but when combined with the divisions and counties, two of those states were eliminated.

Table 9. Geographical MLR results.

	Individual Geographic Models		Combined Geographic Model	
	#	Adj R2	#	Adj R2
Divisions	6	0.1758	2	
States	25	0.3207	23	0.3197
Counties	5	0.0470	1	

MLR with geographic and numerical variables

Having established our baseline model with an Adj R^2 of 0.6631 and a combined geographic model with an Adj R^2 of 0.3197 we looked at combining these variables in an attempt to get a stronger model where geographic variables could better help to predict unemployment.

MLR with all geographical variables that survived the sample size test

Our next regression was to build a model with the geographic variables that passed the sample size test along with all eleven of our numerical variables. As seen in Table 10, we ended up with a strong model. The categorical variables were a subset of those that survived the categorical regression reduction with no Divisions, 13 States, and no Counties. Whereas we thought Inflation would be in our model as it was noted in prior works, it was not, but your new numerical variable (broadband) was in the model.

Table 10. Final MLR with categorical variables N>30

Predictor	b	95% Confidence Limits		Pr > |t|	*beta*	sr^2	VIF
		LL	UL				
Intercept	1,192	1,155	1,231	<.0001	0	.	0
Year	-0.582	-0.601	-0.564	<.0001	-0.509	0.209	1.241
% Broadband Avail	-1.700	-2.126	-1.275	<.0001	-0.065	0.003	1.242
Labor Force Amount	-1.37E-06	-1.58E-06	-1.15E-06	<.0001	-0.160	0.009	2.896
Percent of Population	0.128	0.122	0.134	<.0001	0.345	0.096	1.239
Population of African	2.98E-06	2.28E-06	3.69E-06	<.0001	0.100	0.004	2.609
Arizona	2.982	3.271	2.693	<.0001	-0.155	0.023	1.053
California	2.819	2.980	2.659	<.0001	-0.285	0.067	1.219
Connecticut	1.392	1.753	1.032	<.0001	-0.057	0.003	1.023
Illinois	1.424	1.576	1.273	<.0001	-0.140	0.019	1.038
Iowa	-0.747	-0.582	-0.911	<.0001	0.068	0.004	1.052
Louisiana	0.518	0.699	0.338	<.0001	-0.043	0.002	1.049
Michigan	1.193	1.341	1.044	<.0001	-0.120	0.014	1.032
Nebraska	-0.613	-0.432	-0.795	<.0001	0.051	0.002	1.058
Ohio	0.838	0.977	0.699	<.0001	-0.090	0.008	1.040
Oregon	0.910	1.125	0.695	<.0001	-0.063	0.004	1.022
Pennsylvania	1.124	1.273	0.976	<.0001	-0.115	0.012	1.062
Washington	1.761	1.960	1.562	<.0001	-0.132	0.017	1.032
West Virginia	1.196	1.410	0.982	<.0001	-0.083	0.007	1.024

Fit statistic: Adj R2 = 0.6292 Note: beta is the standard regression weights. sr^2 is the squared semi-partial correlation Type I.

MLR with all geographical variables that survived the MLR reduction modeling.

Since the previous model only included categorical variables that survived the MLR reduction, we chose to run a model that began with only these IVs and the numerical IVs and not all the geographical IVs that survived the MLR reduction.

As seen in Table 11, this MLR included fewer of our numerical variables, and it included our new variable (broadband) but not inflation. It also included an additional two States, but no Divisions or Counties. Compared to the previous model, this model was also not as strong as the previous model indicating that reducing the Divisions, States, and Counties before running this model was not a good idea (Table 12).

Table 11. MLR with categorical variables N>30 and survived categorical MLR

Predictor	b	95% Confidence Limits LL	UL	Pr > |t|	*beta*	sr^2	VIF
Intercept	1069	1028	1110	<.0001	0	.	0
Year	-0.513	-0.534	-0.493	<.0001	-0.449	0.330	1.196
% Broadband Available	-4.324	-4.779	-3.869	<.0001	-0.166	0.018	1.156
Alabama	1.177	-1.546	-1.272	<.0001	-0.175	0.005	1.080
Arizona	3.755	-1.403	-1.102	<.0001	-0.140	0.002	1.068
California	3.103	-1.360	-1.049	<.0001	-0.130	0.001	1.068
Connecticut	1.083	-1.330	-1.003	<.0001	-0.120	0.001	1.076
Florida	1.166	-1.331	-1.002	<.0001	-0.119	0.001	1.066
Georgia	1.409	-3.271	-2.936	<.0001	-0.314	0.059	1.082
Illinois	1.708	-1.858	-1.524	<.0001	-0.170	0.013	1.056
Louisiana	1.733	-1.877	-1.538	<.0001	-0.168	0.015	1.051
Michigan	1.691	-1.369	-0.986	<.0001	-0.102	0.004	1.042
North Carolina	1.252	-1.933	-1.534	<.0001	-0.144	0.013	1.036
Ohio	1.204	-2.263	-1.821	<.0001	-0.153	0.017	1.035
Oregon	1.452	-2.293	-1.818	<.0001	-0.143	0.017	1.026
Pennsylvania	1.166	-1.692	-1.213	<.0001	-0.100	0.008	1.027
Washington	2.042	-4.071	-3.439	<.0001	-0.196	0.037	1.022
West Virginia	2.056	-1.481	-0.685	<.0001	-0.045	0.002	1.016

Fit statistic: Adj R2 = 0.5441 Note: beta is the standard regression weights. sr^2 is the squared semi-partial correlation Type I.

Table 12. Categoricals in ALL MLR w/ multicollinearity

	MLR N≥30	MLR Geog Reduced
Division	0	0
State	13	15
County	0	0
Numerical	5	2
Adj R^2	0.6292	0.5441

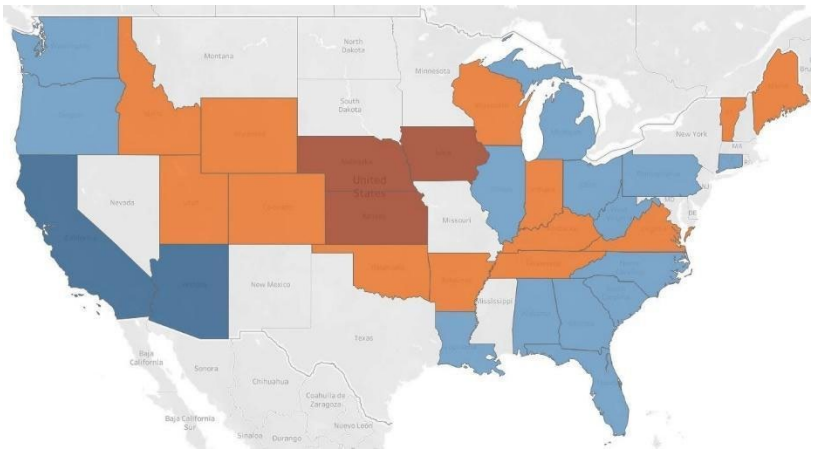
Geographic pattern analysis

Once the geographic variable categories were converted into binary variables, we were able to look at their influence on our DV by using a correlation matrix. We mapped this using the strength of the correlation as well as looking at what variables survived the different regressions. The motivation of this research was to see if broadband impacted unemployment when measuring it at different geographic levels: Division, State, and County. In addition to analyzing these geographic variables in regression with our other variables, here we took a look at geographical differences using Tableau's mapping features without other IVs.

Positive or Negative Influencers.

We could not determine a distinct pattern when looking at divisions' or counties' correlation with unemployment, but when we looked at the states, we saw that there was a stronger negative correlation (red) with states in the center of the US and generally a stronger positive (blue) correlation with states on the West or Southeastern coasts (Figure 1). A positive correlation means that those states were more likely to have more unemployment. Since data is recorded at the county level, this correlation although depicted for each State is measuring correlations for each county within the state with the DV.

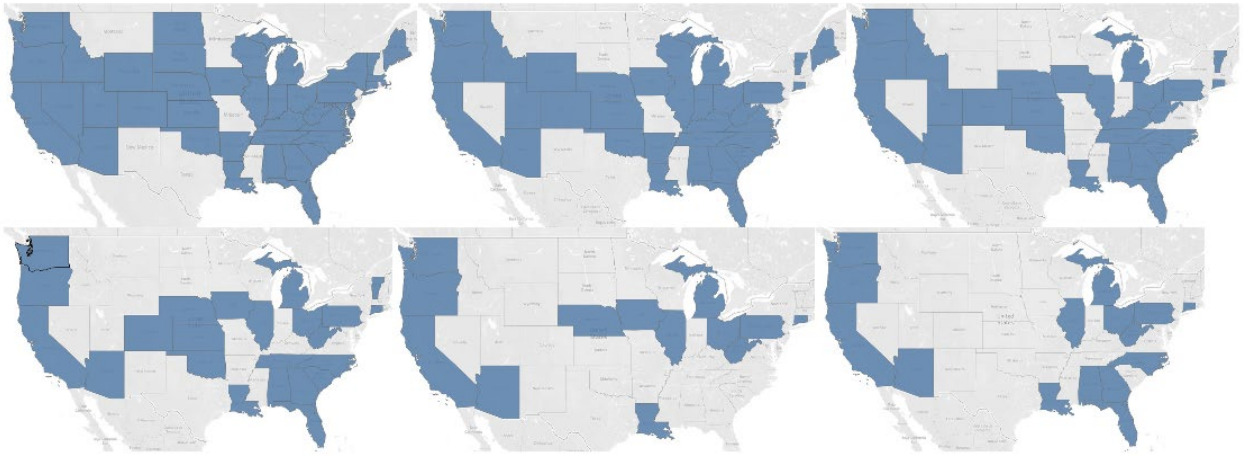
Figure 1. State correlation with unemployment



Geography and Regression.

We began with 40 US States as seen in the far left of Figure 2. The next image is of the states that met the sample size criteria (32 states). As we see on the top right, only 25 of these states were in the regression model with just states and unemployment. The bottom row depicts the 23 states that were in the regression model with Divisions, States, and Counties. The middle bottom image is the model with MLR when the 2 Divisions, 23 States, and 1 county were modeled with the numerical IVs. The final map shows the MLR when all geographic regions that passed the sample size criteria were modeled with the numerical IVs. In general, we saw that the states that had the most impact on unemployment were those on the west coast, the Great Lakes region, and the Gulf/southeast of the US. When comparing these states with the correlation map in ***Figure 1***, those were also the ones with the most positive (blue) correlation with unemployment as shown in Figure 1. This means those states with the most influence on unemployment are also the ones with a stronger positive correlation to unemployment.

Figure 2. States and Regression



A summary of the geographic variable reduction from each of the modeling is summarized in Table 13. They are also the same maps reflected in the State maps in Figure 2, but here you can also see how in each of these runs which ones also had Divisions and Counties in the models.

Table 13. Geographic variables

	N >=30	Individual Geographic Models	Combined Geographic Model	MLR Geog Reduced	MLR N≥30
Division	all 9	6	2	0	0
State	32 of 40	25	23	15	13
County	20 of 1268	5	1	0	0

CONCLUSION

The advancement of broadband availability and speed are improving every day and prior research data is obsolete as soon as it is completed due to this continued advancement. Thus this research and the impact of broadband is an ongoing research area of interest. Prior research did not look at the granularity of broadband's impact at the county level. This research updates past research with newer data, data at the US County level, and adds broadband availability in modeling unemployment.

Insights

There are many reasons to promote more access to broadband internet such as for entertainment, social connection, or decreasing unemployment. Some of the motivation for this research was due to the potential of broadband internet use from both businesses and homes impacts on the economy and ties to impacts on inflation. This drove our focus on independent variables of year (over time), broadband availability, and inflation as predictors of unemployment. When running an SLR, the year was the best predictor of unemployment, and broadband availability was a better predictor than inflation. But when running an MLR, both year and inflation remained in the model with other variables, but broadband did not. The implication was that time itself was a better predictor of unemployment than either broadband availability or inflation. We note however that over time

(as time increased) broadband availability also increased where as inflation fairly stagnated during this time.

One major addition of this research was the granularity of our data at the county level. We note that unemployment takes on a graphical nature and in different areas (counties) there are varying unemployment rates as well as different levels of broadband access. When we introduced our geographic variables into the regression models, the models did not improve, but our new variable of broadband did remain in the model eliminating all the other numeric variables other than year. Thus, when attempting to predict unemployment some geographic variables did remain in the model as predictors and both year and broadband access did as well. This led us to believe that geography and broadband are influencers, but an SLR model with just year is a simpler and more accurate model.

When considering the impact of geography on unemployment we first attempted to use the county-level data but quickly found that the granularity was not practical. Using States, Divisions, and Regions (as defined by the US Census Bureau) did have an impact on the model. Taking a deeper look at these geographic variables we found a striking result. The geographic variables that did impact the regression model were also the geographic variables that had positive correlations with unemployment (more unemployment). Those that had negative correlations with unemployment (more employment) did not. Looking back on the previous paragraph, noting that the numerical variables remaining to predict unemployment were year and broadband access and combining it with the understanding that the geographic features remaining were those predicting more unemployment leads us to want to conduct more research on those areas with the most unemployment over time. They are the areas in the greatest need of job growth.

Overall, what we saw was that broadband availability does impact unemployment when considering county-level data at the State level. If this data is collected again in the future, we should see a direct impact of the recent US investment in broad expansion.

Future Work

This study is limited by only considering 2012 to 2018 data. Obtaining data before 2010 as well as obtaining more current data could strengthen this research into the impacts of broadband on unemployment. During this period, the inflation rate has been relatively small, however, before 2010 as well as in 2021 the inflation rate has shown significant changes. Expanding the time frame of the study could show a larger impact on inflation. But this also has to be weighed with the changing nature of broadband with 4G being introduced in 2011. If studies included data before 2011, they might also need to classify the nature of the broadband availability as 2G, 3G, 4G, or in the future 5G.

An expansion of the time frame would also show significant differences in broadband access. Although access to the Internet by general US citizens began in the 1980s (A Brief, n.d.), access to broadband in US homes did not begin until 2000. (Internet, 2021) This study only covers half the time when we have had access to broadband in US homes. Expanding this study back to 2000 could also shed insight into the impacts of broadband on unemployment as there was more variability in unemployment rates before 2012. This study ends in 2018 which was when the US government began investing in expanding broadband (USDA, 2018). Obtaining more current data

might also show the impacts of the more recent explosion of broadband investment and the impact on unemployment. However, this needs to be carefully analyzed with the impacts of many people working from home during the COVID pandemic.

Lastly, future work should take a specific focus on those areas with the highest unemployment rates as this research showed that those geographic regions had more influence on predicting unemployment than those areas with smaller unemployment rates. The proliferation of broadband may have more impacts on these areas than those that already have low unemployment rates.

REFERENCES

A Brief History of the Internet. (n.d.). *Online Learning Library.* Retrieved December 5, 2002, from https://www.usg.edu/galileo/skills/unit07/internet07_02.phtml.

Adelowokan, O. A., Maku, O. E., Babasanya, A. O., & Adesoye, A. B. (2019). Unemployment, poverty, and economic growth in Nigeria. *Journal of Economics and Management, 35*, 5–17. https://doi.org/10.22367/jem.2019.35.01

Aliyev, K. (2021). Unemployment and (un)happiness: Life satisfaction approach to enhance policy efficiency for developing countries. *Journal of International Studies, 14*(4), 220–235. https://doi.org/10.14254/2071-8330.2021/14-4/15

Barrero, J. M., Bloom, N., & Davis, S. J. (2021, July 1). Internet Access and its Implications for Productivity, Inequality, and Resilience. *National Bureau of Economic Research*. https://www.nber.org/papers/w29102

Bitetti, R. (2018). Unemployment and entrepreneurship: a bottom-up analysis. *SOCIOLOGIA DEL LAVORO, 149*, 94–117. https://doi.org/10.3280/sl2018-149007

Dahliah, D., & Nirwana Nur, A. (2021). The Influence of Unemployment, Human Development Index and Gross Domestic Product on Poverty Level. *Golden Ratio of Social Science and Education, 1*(2), 95–108. https://doi.org/10.52970/grsse.v1i2.84

FRED Economic Data, n.d. *Economic Research Federal Reserve Bank of St. Louis.* Retrieved September 23, 2022, from https://fred.stlouisfed.org/.

Hasbi, M. (2017, June 24*). Impact of very high-speed broadband on local economic growth: Empirica.* 14th ITS Asia-Pacific Regional Conference, Kyoto 2017: Mapping ICT into Transformation for the Next Information Society. Retrieved September 1, 2022, from https://ideas.repec.org/p/zbw/itsp17/168484.html

Hatef, E., Ma, X., Shaikh, Y., Kharrazi, H., Weiner, J. P., & Gaskin, D. J. (2021). Internet Access, Social Risk Factors, and Web-Based Social Support Seeking Behavior: Assessing Correlates of the "Digital Divide" Across Neighborhoods in The State of Maryland. *Journal of Medical Systems, 45*(11). https://doi.org/10.1007/s10916-021-01769-w

Internet/Broadband Fact Sheet. (April 7, 2021). *The Pew Research Center*. Retrieved December 5, 2022, from https://www.pewresearch.org/internet/fact-sheet/internet-broadband/.

Isley, C., & Low, S. A. (2022). Broadband adoption and availability: Impacts on rural employment during COVID-19. *Telecommunications Policy, 46*(7), 102310. https://doi.org/10.1016/j.telpol.2022.102310

Kolko, J. (2010, January). Does Broadband Boost Local Economic Development? - *ppic.org*. Retrieved September 15, 2022, from https://www.ppic.org/wp-content/uploads/content/pubs/report/R_110JKR.pdf

Lobo, B. J., Alam, M. R., & Whitacre, B. E. (2019, June 4). Broadband speed and unemployment rates: Data and measurement issues. *Telecommunications Policy*. Retrieved from ttps://www.sciencedirect.com/science/article/abs/pii/S0308596118303823

National Telecommunications and Information Administration. *NTIA 2021* https://broadbandusa.ntia.doc.gov/resources/federal/federal-funding

Quinton, J. K., Ong, M. K., Vangala, S., Tetleton-Burns, A., Webb, A., Sarkisian, C., Casillas, A., Kakani, P., Han, M., & Pirtle, C. J. (2021). The Association of Broadband Internet Access and Telemedicine Utilization in Rural Western Tennessee: an observational study. *BMC Health Services Research*, 21(1), NA. https://link.gale.com/apps/doc/A675240763/HRCA?u=anon~b4379ed0&sid=googleScholar&xid=ada51b6f

Rohman, I. K., & Bohlin, E. (2012, April 4). Does Broadband Speed Really Matter for Driving Economic Growth? Investigating OECD Countries. *Papers.ssrn.com.* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2034284

The Center on Technology, Data, and Society. (n.d.) *Arizona State University.* Retrieved September 23, 2022, from https://techdatasociety.asu.edu/broadband-data-portal/home

"The World in 2011: ITC Facts and Figures" Archived 2012-05-10 at the Wayback Machine, *International Telecommunication Union (ITU*), Geneva, 2011

UCLA Advanced Research Computing Statistical Methods and Data Analysis. (n.d.) Choosing the Correct Statistical Test. Retrieved August 15, 2021, from https://stats.idre.ucla.edu/other/mult-pkg/whatstat/

USDA Launches New Program to Create High-Speed Internet e-Connectivity in Rural America. (December 13, 2018). *USDA*. Retrieved from https://www.usda.gov/media/press-releases/2018/12/13/usda-launches-new-program-create-high-speed-internet-e-connectivity.

Whitacre, B., & Gallardo, R. (2020). State broadband policy: Impacts on availability. Telecommunications Policy, 44(9), 102025. https://doi.org/10.1016/j.telpol.2020.102025

Why Broadband? (n.d.) *The World Bank*. Retrieved December 6, 2023, from https://ddtoolkits.worldbankgroup.org/broadband-strategies/building-broadband/why-broadband#:~:text=Although%20numerous%20studies%20have%20found,1.50%20percent%20(Figure%201.3).

STREAMLINING BUSINESS CHECK WRITING WITH PYTHON AUTOMATION

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ABSTRACT

Many companies still rely heavily on the usage of business checks to pay employees, partners, and invoices. However, the manual process of writing and formatting these checks can be time consuming and burdensome. Although there are existing automated check writing processes, they are mostly designed to writing an individual checks. In this study, we present an alternative approach to automating the business check writing process using Python. Bulk check writing is where multiple checks are printed from a single input file (.csv,. json, .xml). To accomplish this, we utilize the Python programming language and the Python-docx library. The proposed automation solution allows us to write and format business checks that meet MICR E-13B banking specifications. The process also allows multiple output file formats such as MS docx and PDF. With the utilization of python-docx library, we manipulate a template file using a "search and replace" technique to create formatted checks with the desired information. The results of our study demonstrate the capabilities and the efficiency of the automated business check writing process. To execute the process, users only need to execute a Python program and use an ordinary printer to produce a physical copy of the needed checks. Our approach can easily integrate into existing workflows. This allows businesses to save valuable time and resources while increasing productivity. Overall, the presented automation process provides great economic advantage through its efficiency, accuracy, and speed.

Keywords: MICR, E-13B, Business Check, Python, python-docx

INTRODUCTION

Business checks remain a central avenue for conducting business-to-business, and business-to-employee transactions within the modern economy. According to the Federal Reserve Sites, billions of checks are used annually for exchanging money (Board of Governors of The Federal Reserve System: Commercial Checks Collected Through the Federal Reserve--Annual Data). While the number of paper checks issued has declined due to the availability of alternative payment methods, they still account for a staggering 14.5 billion checks written with a value of $25.80 trillion in 2018 (FRS, 2019). Additionally, in 2018 the average value of check payments grew $1,779 compared to previous years (FRS, 2019). Surprisingly, over 60% of consumers reported using paper checks at least once, and most business and government agencies continue to rely on paper checks (Greene, 2020). As business checks still represents a significant portion of business transactions, they must meet specific criteria to be accepted by the bank as a valid form of payment. Each check in circulation must follow the same characteristics to meet these banking standards.

The standard characteristics of a check must include the payee (the recipient of the payment), the payer, a legal money amount (the written amount on the memo line), a digitized amount (the amount in digits), the date the check was printed, the name of the banking institutions, the account routing number, and account number, the payer's signature, and an MICR E-13B line (Bank of America: MICR Specification Sheet). The E-13B font is the standard practice used by U.S banking institutions, and MICR (Magnetic Ink Character Recognition) is the traditional method for reading characters on checks. Each E-13B character consists of a different magnetic signature, which allows banks to quickly process checks' routing and account numbers based on their magnetic signature.

While the banking industry initially relied on MICR to extract the key information from checks, the past three decades have revealed a more desirable system: Optical Character Recognition (OCR) (Van Steenis, 1971). With OCR, the same check structure can be used without the need for specialized printers to print the E-13B font with magnetic signatures. This allows businesses and users to print their own checks without requiring specialized equipment. Furthermore, it leads to the way for development and implementation of private automated check writing programs.

An automated check-writing program would enable the user to directly upload a data file in any typical format, such as .csv, .json, or .html, to a central database. This data can then be used to create formatted checks that adhere to MICR banking standards and are ready for printing. To accomplish this, the program needs to manipulate a standard document to insert the check information then store it. This document can then quickly be selected and printed on a standard business or consumer printer.

The Python programming language (Python: Python Programming) offers many useful and reliable code libraries that support the development of programs with a wide range of advanced functionalities. One such key library for document manipulation is the python-docx library (Python: python-docx). This library enables developers to search or parse through a word document and replace keywords with the appropriate text, making it a crucial tool for document manipulation automation. These keywords serve as indicators for the text fields. Identifying specific text fields where the respective information needs to be placed is essential for the success of the automation process. During the development of check writing automation in Python, this technique is the backbone. By manipulating a properly formatted template that follows MICR compliance, we can generate and print checks. This project aims to implement an automated business process for bulk check writing by leveraging the power of automation in Python.

MICR LINE AND OCR IMPLEMENTATION

The E-13B MICR line is the standard for the banking industry to verify the validity and utilization of a check (Kelechava, 2020). This system was adopted so that check-processing machines can quickly read the magnetic signature contained on the band and process the origin and routing information of the check. The font remains constant despite the presence of more modern forms of check-processing methods, such as OCR (Chin & Wu, 1995). The advantages ushered along with OCR include the ability to produce checks using any printer as long as the proper anti-copying check paper is used. Without requiring specialized printers to produce checks, businesses can drastically reduce expenses on equipment and specialized software.

The recent implementation of OCR for reading MICR lines involves the use of ANN (Artificial Neural Networks) to analyzes each character in the line and determine the respective routing and account numbers. ANN, a technique that trains a computer to learn a key characteristic and create patterns for predicting output based on similar input, is employed in OCR. With OCR, ANN is designed and implemented to predict the character or ASCII value of writing on paper, or in a digitalized format such as a pdf or image file (Zhang, 2008).

The OCR process has significantly reduced the cost of check-reading and writing software, as ordinary printers can now be used to write checks as the magnetic signatures are no longer necessary. Additionally, check readers now can capture images of incoming checks and process them using OCR techniques to identify check amounts, account and routing numbers, and other relevant checking information.

AUTOMATED DOCUMENT WRITING

Automated document writing has been implemented to modify, save, and print research paper abstracts in research journals. The principals of the study involve utilizing Python and the python-docx library to manipulate .docx files. The study found that utilizing the python-docx library could greatly improve the efficiency of adding the journal abstracts to the journal (Ilina & Pelevanyuk, 2020). Implementing the python-docx library to automate the replication of journal papers is just one example of the library's potential, as it could also be utilized to write check-specific information onto a business check template.

The python-docx library has been implemented as a "search and replace" tool for the migration of legacy clinical data (Dunn, Cobb, Levey & Gutman, 2016). In this role, the python-docx library is responsible for searching for keywords within a document and replacing them with the accurate information retrieved from a central database. The search and replace functionality it very useful when maintaining document formatting is involved. By creating a central document with appropriate formatting and keywords, the search and replace utility ensures that the desired information is inserted into the document while maintaining the intended formatting.

Program Requirements

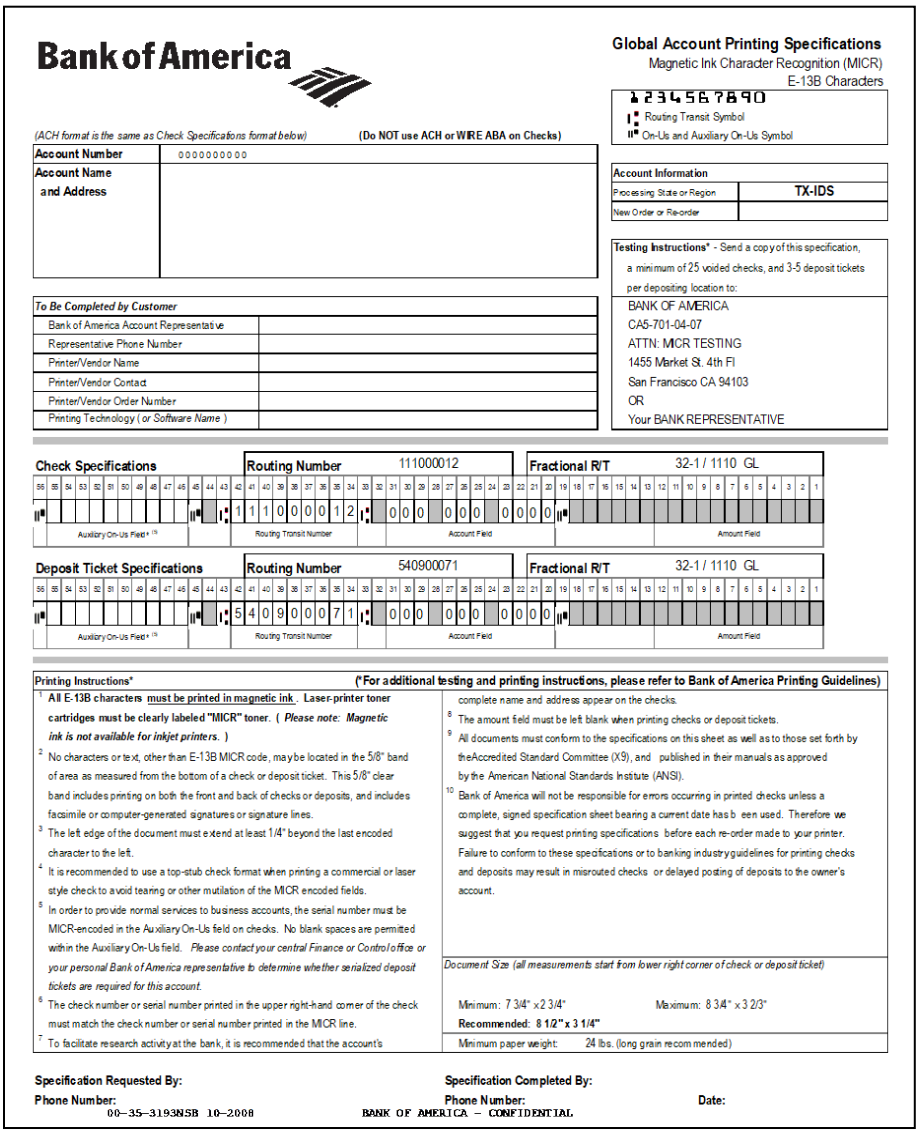
To automate the check writing process in Python, certain output features must be achieved. These requirements shape the design, implementation, and tools utilized in order to automate business check writing. The program should be capable of reading check information (objects) from an input file. The input file can be formatted as a comma-separated values (.csv) file, JavaScript Object Notation (.json) file, or extensible markup language (.xml) file. These file types offer flexibility in creating an input checkbook and do not restrict to a single input parameter.

The program must format a memo table that is displayed above the check, showing the charges associated with the check. This feature allows each printed check to display where the funds are going via an invoice number, invoice date, and individual charges corresponding to that check number.

Each printed check must comply to the MICR banking specifications, ensuring that the appropriate check fields are displayed on the check, such as amount, payee, signature, bank, and other required information.

Each printed check must include a MICR line with appropriate information (check number, routing number, and account number) in the E-13B font. This is crucial as the MICR line is the key component in check processing with OCR. Formatting the MICR line to meet MICR banking specifications is essential for producing usable and legally compliant checks.

The check specifications are based on the Bank of America check specification sheet (Bank of America: MICR Specification Sheet) . This document outlines the proper formatting for the check. The check specification sheet is provided to check printers so that they produce Bank of America compliant checks. This sheet serves as a central guideline for how the output checks should be displayed (Figure 1-3).



Bank of America

Global Account Printing Specifications
Magnetic Ink Character Recognition (MICR)
E-13B Characters

1 2 3 4 5 6 7 8 9 0
Routing Transit Symbol
On-Us and Auxiliary On-Us Symbol

(ACH format is the same as Check Specifications format below) **(Do NOT use ACH or WIRE ABA on Checks)**

Account Number	000000000
Account Name and Address	

Account Information	
Processing State or Region	**TX-IDS**
New Order or Re-order	

Testing Instructions* - Send a copy of this specification, a minimum of 25 voided checks, and 3-5 deposit tickets per depositing location to:

BANK OF AMERICA
CA5-701-04-07
ATTN: MICR TESTING
1455 Market St. 4th Fl
San Francisco CA 94103
OR
Your BANK REPRESENTATIVE

To Be Completed by Customer	
Bank of America Account Representative	
Representative Phone Number	
Printer/Vendor Name	
Printer/Vendor Contact	
Printer/Vendor Order Number	
Printing Technology (*or Software Name*)	

Check Specifications — **Routing Number** 111000012 — **Fractional R/T** 32-1 / 1110 GL

Auxiliary On-Us Field * | Routing Transit Number | Account Field | Amount Field

Deposit Ticket Specifications — **Routing Number** 540900071 — **Fractional R/T** 32-1 / 1110 GL

Auxiliary On-Us Field * | Routing Transit Number | Account Field | Amount Field

Printing Instructions* **(*For additional testing and printing instructions, please refer to Bank of America Printing Guidelines)**

1 **All E-13B characters must be printed in magnetic ink . Laser-printer toner cartridges must be clearly labeled "MICR" toner. (*Please note: Magnetic ink is not available for inkjet printers.*)**

2 No characters or text, other than E-13B MICR code, may be located in the 5/8" band of area as measured from the bottom of a check or deposit ticket. This 5/8" clear band includes printing on both the front and back of checks or deposits, and includes facsimile or computer-generated signatures or signature lines.

3 The left edge of the document must extend at least 1/4" beyond the last encoded character to the left.

4 It is recommended to use a top-stub check format when printing a commercial or laser style check to avoid tearing or other mutilation of the MICR encoded fields.

5 In order to provide normal services to business accounts, the serial number must be MICR-encoded in the Auxiliary On-Us field on checks. No blank spaces are permitted within the Auxiliary On-Us field. *Please contact your central Finance or Control office or your personal Bank of America representative to determine whether serialized deposit tickets are required for this account.*

6 The check number or serial number printed in the upper right-hand corner of the check must match the check number or serial number printed in the MICR line.

7 To facilitate research activity at the bank, it is recommended that the account's complete name and address appear on the checks.

8 The amount field must be left blank when printing checks or deposit tickets.

9 All documents must conform to the specifications on this sheet as well as to those set forth by the Accredited Standard Committee (X9), and published in their manuals as approved by the American National Standards Institute (ANSI).

10 Bank of America will not be responsible for errors occurring in printed checks unless a complete, signed specification sheet bearing a current date has been used. Therefore we suggest that you request printing specifications before each re-order made to your printer. Failure to conform to these specifications or to banking industry guidelines for printing checks and deposits may result in misrouted checks or delayed posting of deposits to the owner's account.

Document Size (all measurements start from lower right corner of check or deposit ticket)

Minimum: 7 3/4" x 2 3/4" Maximum: 8 3/4" x 3 2/3"
Recommended: 8 1/2" x 3 1/4"

Minimum paper weight: 24 lbs. (long grain recommended)

Specification Requested By: **Specification Completed By:**
Phone Number: **Phone Number:** **Date:**

00-35-3193N5B 10-2008 BANK OF AMERICA – CONFIDENTIAL

Figure 1. Bank of America Spec Sheet 1

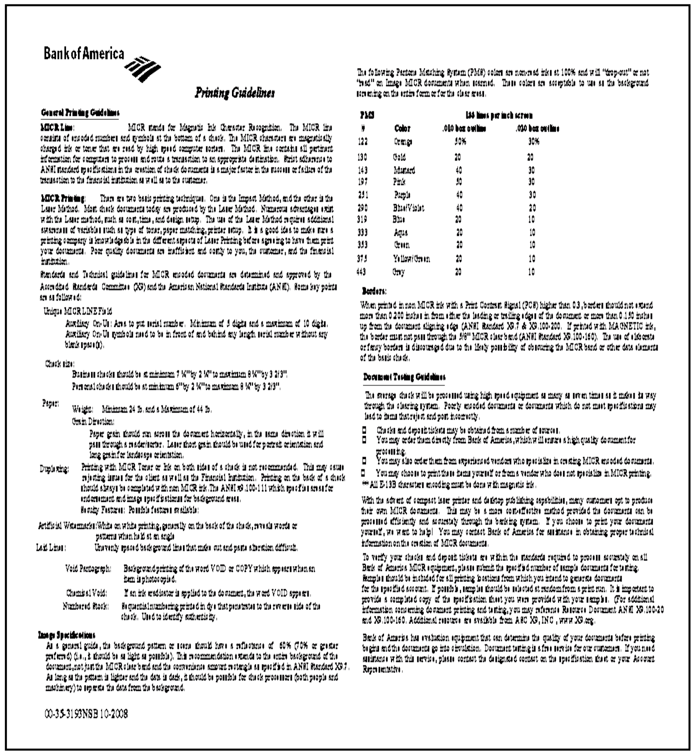


Figure 2. Bank of America Spec Sheet 2

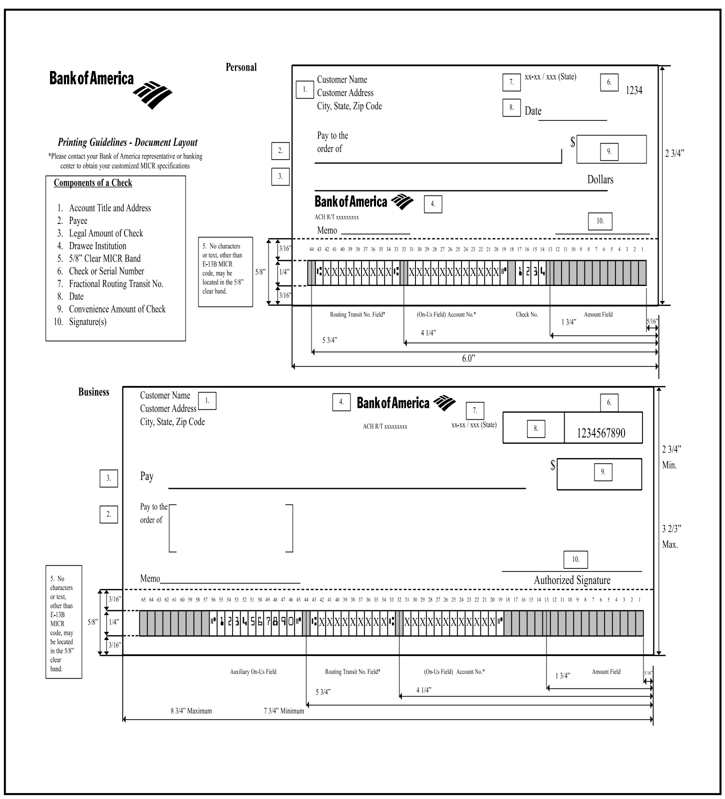


Figure 3. Bank of America Spec Sheet 3

Architectural Design

The program's architectural design was implemented using object-oriented programming, which involved creating classes for convenient variable storage objects (checking, banking, account information) that can be reused throughout the program. As shown in Figure 4, The backend design of the application focuses on creating key objects used throughout the application. Additionally, the backend design provides classes that compose the main functionality of the program. The core objects include: the Check object, which stores relevant check information; the Bank object, which stores information about the bank for which the check is formatted; the Company object, which stores information related to the company printing the check; the Signature object, utilized for storing an image of an authorized signee to be displayed on the check; and finally, the Account object, which stores the account number and routing number to be displayed in the MICR line of the check.

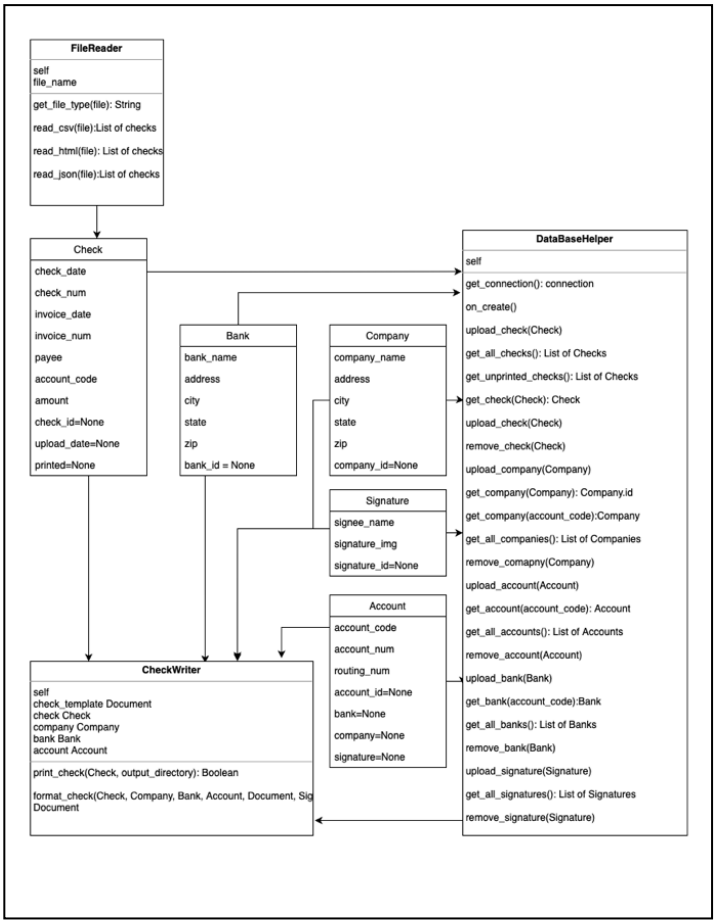


Figure 4. Backend UML

The FileReader, CheckWriter, and DatabaseHelper classes serve as the core functionality of the program. The FileReader class is responsible for parsing an input file and extracting the respective business checks (Check objects) from the file. The ChekWriter class is responsible for implementing the 'search and replace' technique to format and output the business check accordingly. Finally, the DatabaseHelper class contains all the methods used in the database interactions, including uploading, updating, and retrieving data.

The frontend design of the program (Figure 5) revolves around designing the classes used to create the user interface and implement the backend to the UI. The fronted implements objects and methods from the Tkinter user interface module (Python documentation: Tkinter). The Tkinter module enables the creation of the application window, content and navigational frames, as well as widgets such as buttons and labels, and provides formatting options for these objects. The frontend design focuses on the display of the user interface and provides an environment for the user to interact with the backend functionality.

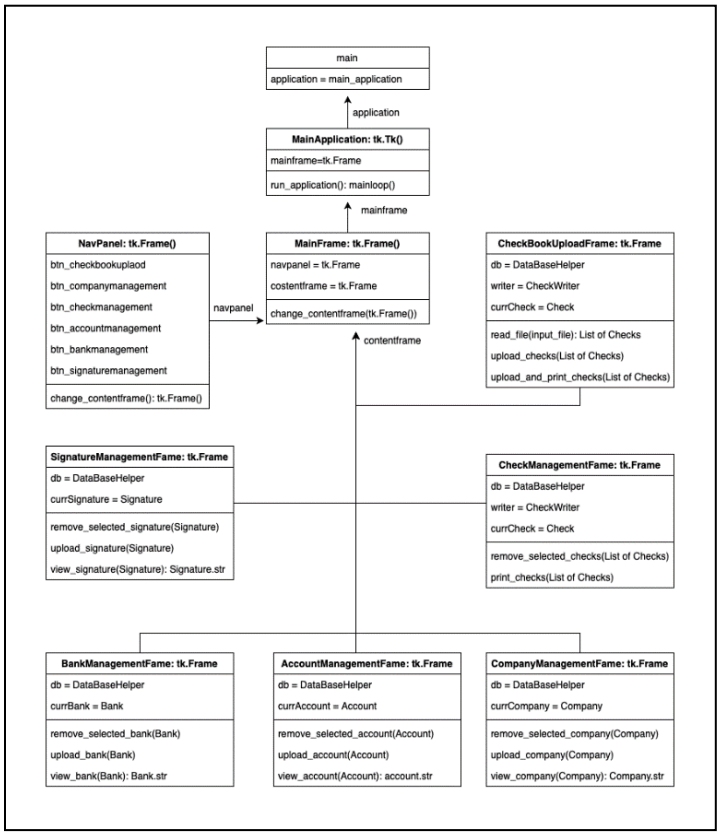


Figure 5. Frontend UML

The tk.Tk class is a class provided by the Tkinter library in Python. The Tk object is the Tkinter object responsible for displaying the main application window and set up the basic structure for creating GUI. The Tk object can display tk.Frame objects within them and thus, serve as a background from which the content is pasted upon.

The tk.Frame class is another class provided by the Tkinter library in Python. Instances of the tk.Frame class can create sections within the main window where we can place widgets as needed, such as buttons, labels, list boxes, and entry forms. These classes are called and displayed within the Tk() class.

The Full UML design, as shown Figure 6, illustrates the integration of the fronted architecture with the backend architecture. This diagram provides insight into the flow of the application. The backend classes from Figure 4 are shown at the bottom of the full UML as they supplement the functionality and objects utilized within the frontend of the application. The frontend design

classes from Figure 5 are positioned above the backend classes as they inherit the backend classes. The frontend classes are further inherited by the main application, which executes the application using the Tkinter.mainloop() function. This function displays the window where the content is displayed, making it the main function for running the program.

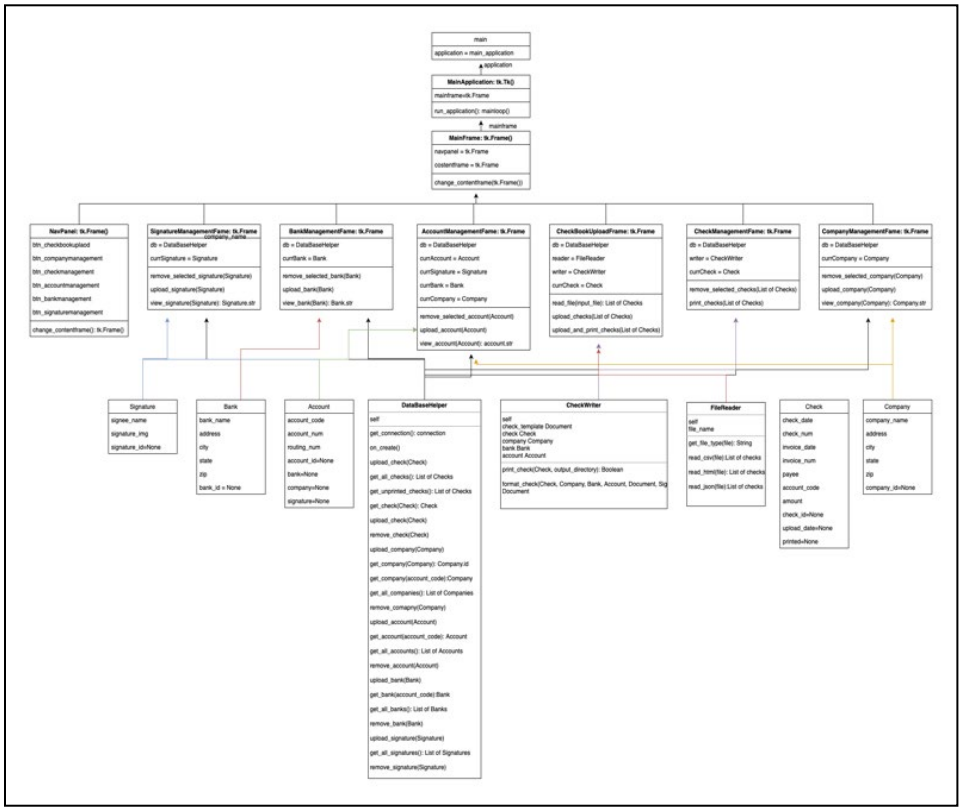


Figure 6. Full UML

Database Design

The database is responsible for storing essential information used throughout the application. The information stored within the database closely correlates with the class objects present in the backend of the application (as shown in Figure 4).

The database is built using a SQL (Structured Query Language) database, which is a key component for designing and creating relational databases (SQLCourse, 2000). Relation databases establish tables or entities and relationships between them. The ERD (Entity Relationship Diagram) shown in Figure 7 illustrates the database design and connections between working components of the application.

The database stores and manages entities such as company, signature, bank, and check, which align with the objects used in the backend of the application. This connection allows the program to seamlessly upload and retrieve relevant information from the database. As a result, we can obtain required information from the database to print checks.

The company entity table stores company information to be displayed on the check. Each entry in the table is assigned a unique company id as primary key that maintains the separation and uniqueness of the entries. The company table also includes the company name and address information, which are needed on the printed check.

The signature entity table stores the necessary information for displaying a signature on the check. These fields include a signature id as the primary key to ensure distinct entries. Additionally, the signature table includes the signee's name, and a file path to an image file of their signature, which is used on the printed check.

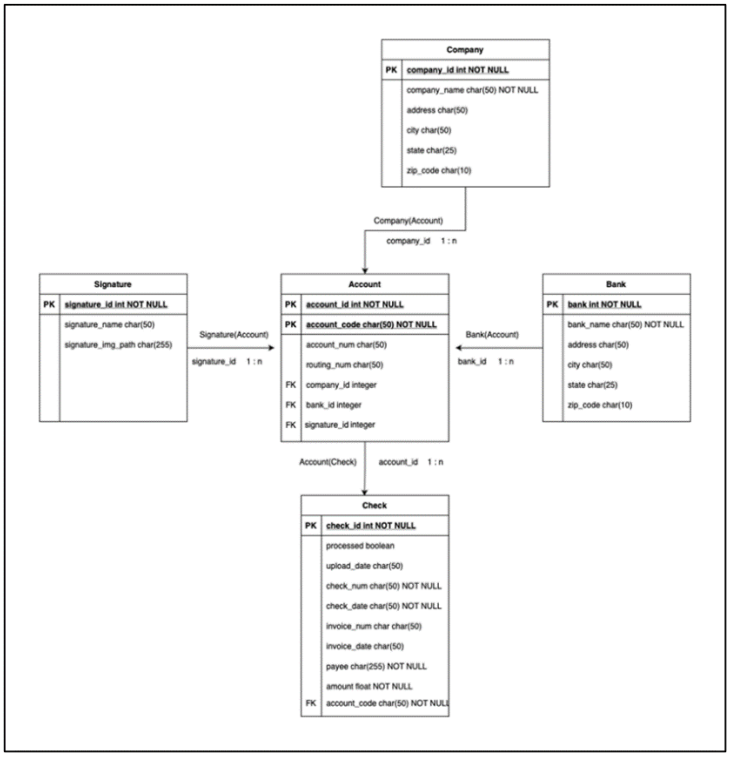


Figure 7. ERD Design

The bank entity table stores banking information used to display bank information on the check. This table includes a unique bank id, the bank name, and the address of its headquarters.

The account entity table stores critical account information. Each account entry has a unique account id, the account's routing and account number, and a unique account code identifier. Additionally, it establishes connections with the Signature, Bank, and Company tables.

The account entity establishes a one-to-many relationship with the bank entity. That means that an account can be linked to only one bank, while a bank can be linked to multiple accounts. The relationship is established via making bank id as a foreign key of the account entity.

The account entity also establishes a connection to the company entity by introducing the company id as a foreign key identifier. This relationship is also a one-to-many relationship where a single company can have multiple accounts linked to it, while an account can only be linked to a single account.

The account entity establishes a many-to-one relationship with the signature entity by including the signature id as its foreign key field. This relationship allows one signature image to provide a signature for many accounts while a single account can only have a single signature tied to it.

The check entity table stores the relevant information of the check object while establishes a one-to-many relationship with the account entity table. The check table uses a check id as its unique primary key. Besides that, it stores the invoice number, invoice date, check number, check date, payee, amount , and account code. The account code field serves as a foreign key. A single check connects to a single account (and therefore inherits the accounts connections), whereas an account can be linked to many Checks.

This design ensures that any check recorded in the database can be associated with its corresponding bank, company, and signature through the established relationships.

User Interface Design

The program's user interface is designed to offer users with all the essential information and handle the required tasks in a user-friendly manner. The UI window design allows users to interact with a content frame that displays key information, while a navigation panel enables them to seamless navigate throughout the application.

The checkbook upload frame (shown in Figure 8) allows users to upload a file and carry out any necessary actions on the checkbook. Once the file is uploaded, the extracted checks populate the label (white space) for user review. Users can choose to either upload the checkbook or upload and print it.

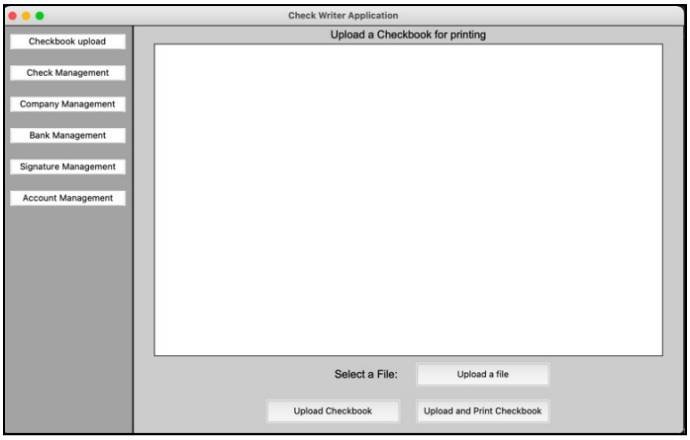


Figure 8. Checkbook Upload Frame

The check management frame (shown in Figure 9) enables users to navigate through all the checks stored in the database. This frame allows users to sort the checks by specific information and customize which components are included in the sorted checks using checkboxes. Users can then select checks from the list-box (white space) and choose to print those checks or delete them accordingly.

The company management frame (shown in Figure 10) allows users to view, add and remove companies from the database. The user can add new companies using the entry fields on the right side of the panel. Additionally, companies that have already been uploaded are displayed on the left side. Users can view their information or remove them from the database permanently.

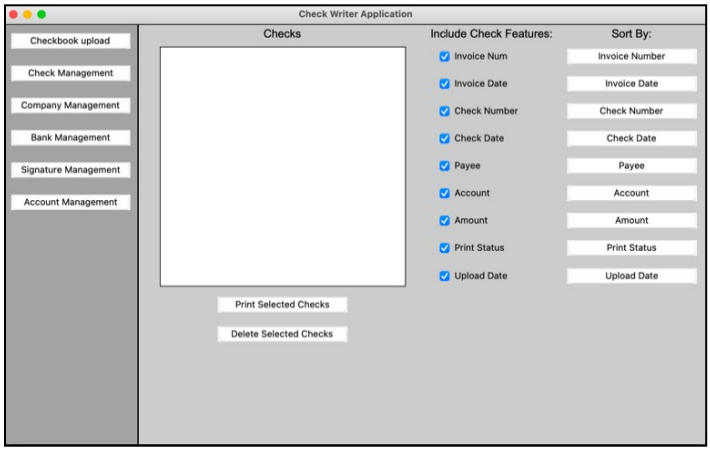


Figure 9. Check Management Frame

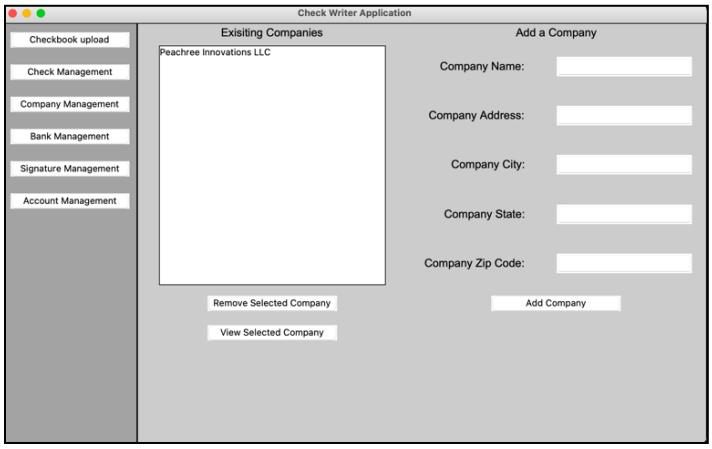


Figure 10. Company Management Frame

The bank management frame (shown in Figure 11) allows the user to interact with the bank objects stored in the database. The right side of the frame allows the user to add a new bank to the database. While the left side of the frame allows the user to view, or remove existing banks form the database.

The signature management frame (shown in Figure 12) allows users to upload a signature image, and view or remove stored signatures. The signature objects stored in the database are stored within the list-box for display.

The account management frame (shown in Figure 13) allows users to manage accounts stored in the database, including creating, viewing, and removing accounts. To create additional accounts, users input the required information in the entry fields and select the corresponding bank, company , and signature objects from the dropdown selection menu. Existing accounts are displayed using

their account code, but users can expand them to view their full information or remove them from the database.

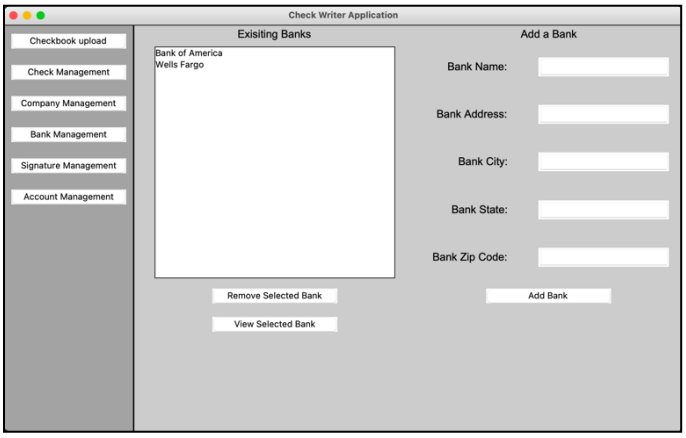


Figure 11. Bank Management Frame

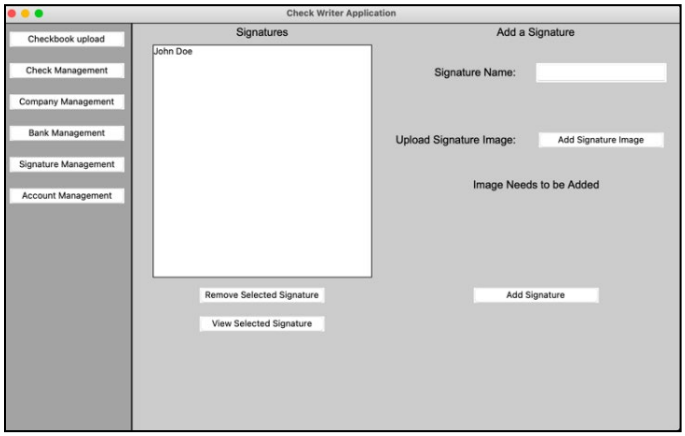


Figure 12. Signature Management Frame

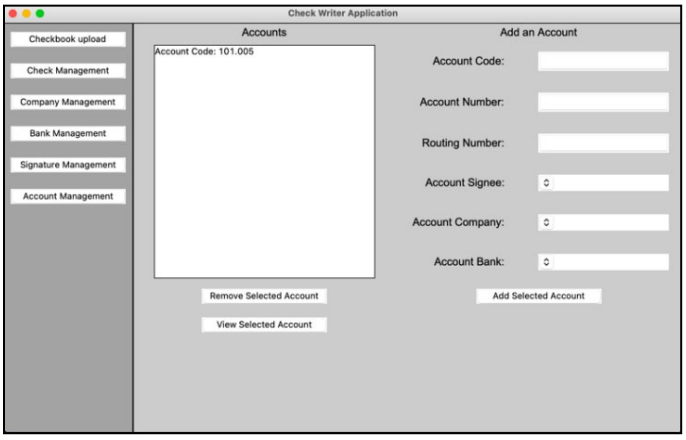


Figure 13. Account Management Frame

Utilized Tools and Libraries

To Implement the program, a number of development tools were utilized including Python 3.9.5, Microsoft Word, SQLite3, and Tkinter. The program was developed using the Python programming language (version 3.9.5). Several Python libraries were utilized. Python-docx was utilized for manipulating the check template and formatting the checks for printing. Python-docx's .save() method enabled the finished check to be output as a .docx file. The python-num2words library was used for converting the digitized amount into the amount in written format. The python-docx2pdf library allowed for the conversion of output .docx files to .pdf files. The python-json library enabled the program to read .json input checkbook files. The python-csv library allowed the reading of .csv input checkbook files. The python-os library provides a support to work with various operating system modules, such as saving image files, renaming files, and creating directories. The python xml.etree.ElementTree API module was used for reading .xml input checkbook files.

The check template (shown in Figure 14), which is central to the search and replace functionality of the application, was created using Microsoft Word. The template was created using Word's formatting tools and saved as .docx file for manipulation with python-docx. In addition to the creation of the check template, Word also plays a central role in the file manipulation process.

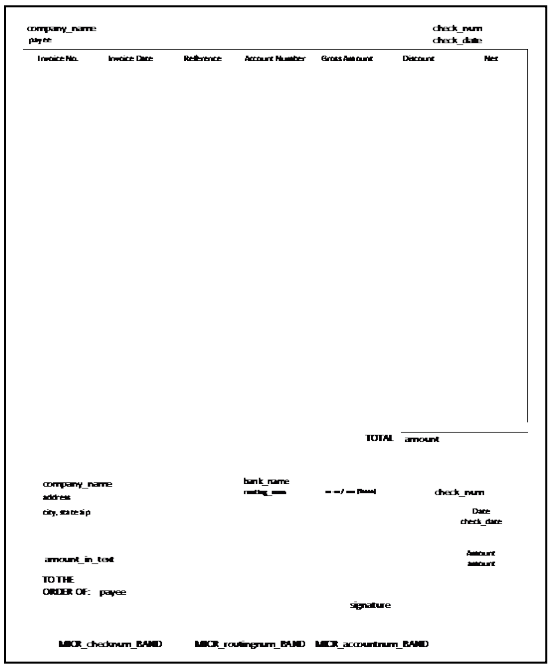


Figure 14. CheckTemplate.docx

The check template is formatted to include all the necessary check components identified by their respective keywords. This template is also formatted to ensure proper alignment of the MICR band on the printer paper and within the printing range of commercial printers. Tkinter is a user interface builder that allows the creation of application windows using widgets and various placement methods (Python documentation: Tkinter). It provides a grid feature for organizing widgets on the frame/window, allowing them to maintain proper spacing and structure. Tkinter is bundled with Python 3.

SQlite3 is a built-in database included with Python 3. It allows for the creation of relational databases that are housed 'on-board' or at a specific file location and accessed via file location rather than an internet connection (SQLite). SQLite3 was responsible for the creation of the database and store relevant database information.

IMPLEMENTATION

The FileReader class is a central component in the program as it parses information from an input file and extracts embedded check objects. The FileReader class is initialized as an object and can be declared without any input parameters. It utilizes a get_file_type method to determine the input file type. The file type can be determined based on file's extension, which is obtained using a python-os method called 'endswith'. The extension is then compared to a list of supported extensions to find a match.

Checks being printed by the print_check() method need to be evaluated to determine whether it is a multi-charge check or singular charge check. A multi-charge check consists of a list of embedded check objects within the checklist (Ex. Check, Check, [Check, Check = 3 Checks]) to represent multiple charges or invoices being paid by a single check. The isinstance() method is used to determine if a check is a multi-charge check or a singularly charged check. If the isinstance() method returns true, it indicates that the check is multi-charged and requires a different formatting method.

Each check in the checkbook has its corresponding account, bank, company, and signature information retrieved from the database using the check's account code attribute. With this information, the method formats the python-docx document using a series of sub-methods in format_check() function. Once a complete and formatted check being returned from format_check(), the document is then saved to the desired output.

Each check needs to contain a written format amount. To automate this process, the program uses the format_amount_text() method to add the written amount to the check. This method replaces the written amount keyword with a string representation of the check amount in words.
To convert the amount of the check into words requires the utilization of python-num2words library. This library can generate the written representation of numbers passed into the num2words() method. To ensure precise conversion, the method isolates the dollar amount from the total amount. This is achieved by converting the amount from a float to an integer (ex. float(23.33) = int(23)). To separate the decimal or cent amount of the check (which is displayed as a fraction on the check (.33 = 33/100)), the method subtracts the dollar amount from the total amount. The cent amount is then obtained by multiplying the decimal by 100 to convert it to a whole number for display. Once the dollar and cent amounts are isolated, the dollar amount is converted to words and the cent amount is set as a fraction out of 100. These two strings are then combined to generate the amount line in words accordingly.

The check signee's signature is displayed on the check's signature line via an uploaded image of their signature. The format_signature() method is responsible for replacing the signature keyword with a signature image. To achieve this, the method removes the signature keyword and utilizes the python-docx run object to insert the signature image into the document. When the image is

added to the document, its height is set to half an inch to occupy an appropriate amount of space, and the width will auto-fill based on the image's height.

To format the MICR band, the appropriate fields (check number, routing number, account number) use methods to replace MICR keywords with the E-13B font and corresponding symbols. These methods iterate through each digit in the respective number. For each digit, a python-docx run object inserts an image of the E-13B character representing that digit (e.g., '1' inserts the E-13B '1' character). This allows the MICR band to be formatted with the E-13B font and can be placed on the check.

The MICR formatting methods follow the same basic structures for inserting MICR character images. To obtain the MICR image, the formatting methods utilize the get_MICR_char_path() method, which returns the image of the E-13B character based on the character passed to the method using a switch statement.

RESULTS

The FileReader class is used to parse an input file and extract check objects from it. It determines the file type based on the file extension and uses different formatting methods for multi-charge checks and singular charge checks. The program uses the python-num2words library to convert the check amount to words for the written amount on the check. The check signer's signature is added as an image using the format_signature() method. The MICR band is formatted using methods that replace MICR keywords with E-13B font and corresponding symbols. The formatting methods use the get_MICR_char_path() method to obtain images of the E-13B characters.

The program successfully reads data from an input file and outputs the checks from the file as a .docx or .pdf file. These output files contain checks that are properly formatted. Figure 15 displays a formatted check example produced by the program. The output file displays the paying company and payee in the top left corner. The check number and check date are displayed in the top right-hand corner. The memo table is displayed in the center showing the check amount.

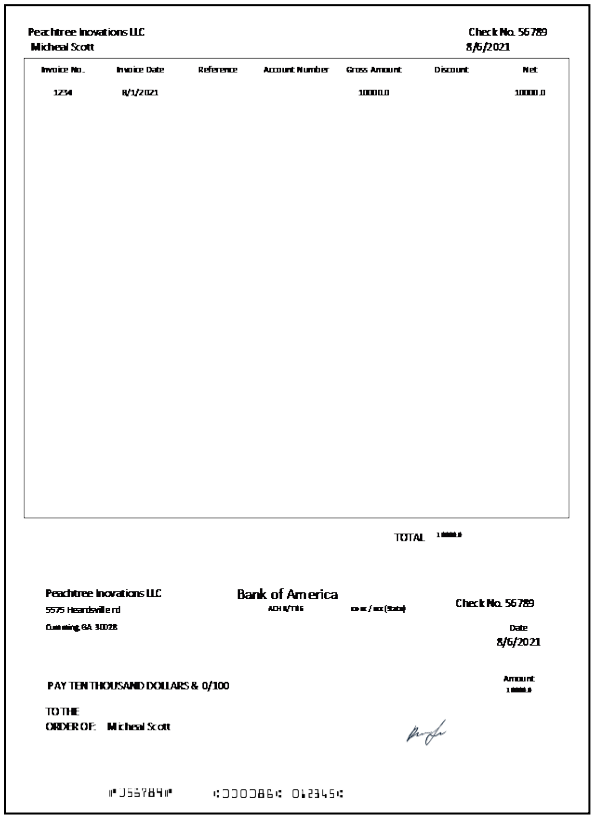


Figure 15. Output File of a Singular Charge Check

The check on the output file contains all necessary information, and all the required elements are presented and properly formatted. Furthermore, the MICR line is properly aligned at the bottom of the check, with the appropriate symbols (‘on-us’ & ‘transit’) in place.

The output file, as shown in Figure 16, displays a printed multi-charge check example. It differs from the output of a singular charge check (shown in Figure 15), as it displays multiple items within the memo table. These charges amounts are summed to display the total amount.

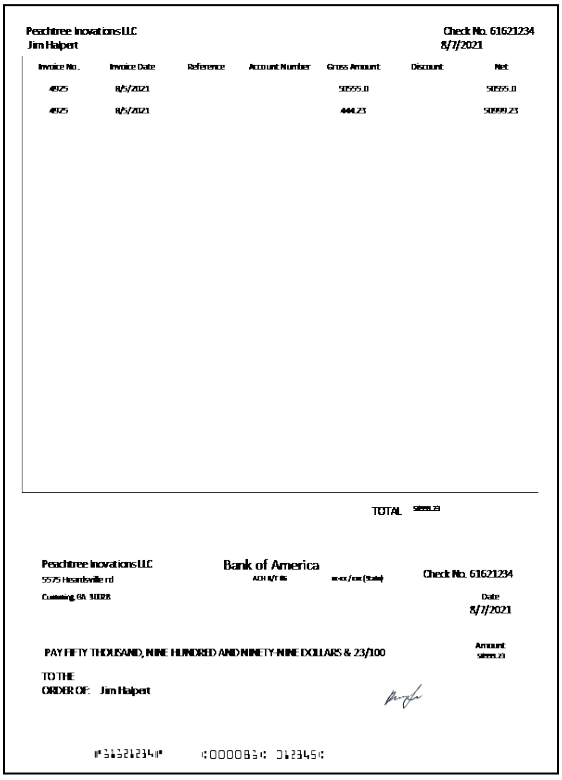


Figure 16. Output File of a Multi-Charge Check

CONCLUSION

The automation of the business check writing process using Python brings the advanced business check writing capabilities to end users. With the ability to execute a Python file and an ordinary printer, users can automate the check writing process and easily print physical copies of check. The automation allows companies to significantly save resources and time, greatly speeding up the check writing process.

This paper presents an automated process for bulk check writing using the Python programming language and Python-docx library. This process provides a more efficient way of writing and formatting multiple business checks from a single input file, such as .csv, .json, or .xml, and supports output in various file formats. The Python-docx library is used to manipulate a template file using a search and replace technique to create formatted checks with the desired information, meeting MICR E-13B banking specifications. The automated process provides a more efficient, accurate, and speedy way of writing and printing business checks, requiring only a Python program and an ordinary printer.

REFERENCES

Bank of America (2008), MICR Specification Sheet, *Bank of America*. Retrieved from http://www.internationalpcg.com/documents/MICRSpecs.pdf

Chin, F. & Wu, F. (1995), A Microprocessor-Based Optical Character Recognition Check

Reader, *Proceeding of 3rd International Conference on Document Analysis and Recognition*, Montreal,QC, Canada. Retrieved from https://ieeexplore.ieee.org/abstract/document/602066

Commercial Checks Collected Through the Federal Reserve--Annual Data (n.d.), *Board of Governors of The Federal Reserve System*. Retrieved from https://www.federalreserve.gov/paymentsystems/check_commcheckcolannual.htm

Dunn W., Cobb J., Levey A. & Gutman D. (2016), Redletr: Workflow and Tools to Support the Migration of Legacy Clinical Data Capture Systems to Redcap, *International Journal of Medical Informatics*, vol. 93, 2016, pp. 103–110. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S1386505616301447

Ilina A. & Pelevanyuk I (2020), Automated Generation of A Book Of Abstracts For Conferences That Use Indico Platform, *Proceeding Of International Conference On Data Analytics And Management In Data Intensive Domains*, Voronezh, Russia. Retrieved from https://ceur-ws.org/Vol-2790/paper28.pdf, Central Russia

Kelechava, B. (2020, June 8), MICR Specifications For Checks In ASC X9 Standards, The ANSI. Retrieved from https://blog.ansi.org/2020/01/micr-specifications-checks-ansi-x9-standards/#gref

Python Progamming (n.d), *Python.org*, Retrieved from https://www.python.org/

Python-Docx (n.d.), *Python-docx*. Retrieved from https://python-docx.readthedocs.io/en/latest/

SQLCourse (2000), *SQLCourse.com*. Retrieved from: http://www.sqlcourse.com/intro.html.

SQLite (n.d.), SQLite.org. Retrieved from: https://www.sqlite.org/index.html.
Tkinter - Python interface to Tcl/Tk (n.d.), *Python 3.9.6 documentation*. Retrieved from: https://docs.python.org/3/library/tkinter.html

Van Steenis H. (1971), The IBM 1275 Recognition System and Its Development, *International Conference on Pattern Recognition in Biological and Technical Systems*, Springer, Berlin, Heidelberg. Retrieved From https://link.springer.com/chapter/10.1007/978-3-642-65175-5_24

Zhang, P. (2008), Ensemble Classifier and Its Application to Image Based MICR Character Recognition, *International Conference on Machine Learning and Cybernetics*, KuMing, China. Retrieved from: https://ieeexplore.ieee.org/document/4620375

THE PHYSICAL FIRM: IS IT NECESSARY FOR 21st CENTURY ACCOUNTING?

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ABSTRACT

This study was conducted to evaluate the possibility of an accounting firm existing without physical office space. Developing a virtual firm is a response to the idea of a work-life balance, the pandemic and advanced technology. The study evaluated the effects of a virtual office on the employee, management, and the firm. There are no prior studies directly related to a firm without an office, but five studies were used to discover what the advantages and disadvantages are when having employees work from outside an office. The previous studies focused on how a healthy work-life balance affects employees, how employees working on flextime affect the firm, how telecommuting employees affect management and the firm, and how various work arrangements affect employees. Management values face-to-face interaction with their employees, causing issues for managers with employees who work at locations outside the office. The research question asks if a physical firm is necessary for 21st-century accounting, and the research shows the answer to that question is no, a physical firm is not necessary. Not having a physical firm would save the firm in cost, help create a healthy work-life balance for employees, and decrease employee turnover. However, the lack of a physical firm will make it difficult for managers to manage their employees due to the loss in face-to-face interaction a physical firm provides.

Keywords: accounting, virtual, work-life balance, firm, 21st century

INTRODUCTION

Imagine being a licensed CPA working for a well-known CPA firm for which their business cards do not have an address on them. Implicating this development is the CPA firm no longer has an office for its employees to work from every day, but instead their employees work from wherever is convenient for them (Pickard, Schuetzler, Valacich, & Wood, 2020) home, coffee shop, library, and park (Alexander, Dijst & Ettema, 2010).

A common issue for people in public accounting is the idea of a work-life balance, which has been a hot topic of conversation in recent years. In response to this development, many CPA firms have provided their employees with options such as flex-time, which has allowed employees to adjust their time in the office in a way that fits their schedule better to handle their lives outside of work (Church, 2015; Vera-Mun˜ oz, Ho, & Chow, 2006). By making these adjustments for their employees the CPA firms are attempting to reduce their employee turnover rates.

Telecommuting, which is the idea of working from a location outside of the office using the internet and technology in some way to complete the job, exists in accounting without people

realizing the greater effects it may have on the profession (Wang, Liu, Qian, & Parker, 2020). The immediate effects from telecommuting on the workforce include reducing the use of gasoline, saving time from commuting, saving financially on costs of travel, food, and parking, and the employer saving on healthcare, office expenses, and potentially daycare (Broman, 2014).

The digital age has continually developed in recent years, causing a change in how accountants complete their work. Laptops, tablets, and programs are relied on more heavily now than ever before. This development has led to creating the virtual office, which is used by accounting firms everywhere. This virtual office allows employees to work together simultaneously on jobs from their device if they have an Internet connection (Abrams, 2019). The virtual office also allows for accountants to communicate and share information with each other quickly and efficiently (Drew, 2013).

The reader will gain an understanding of when a physical location might be best. Additionally, an understanding of how work-life balance is impacted by physical location and the impact on employee performance. If the physical location is eliminated, readers will understand the impact on organization expenses.

The purpose of this study is to view the implications of merging these ideas of telecommuting, work-life balance, the virtual office, and the factors that make a strong CPA firm together. Intensifying the idea of telecommuting to the point where employees only telecommute and never have to go to an office to work has the potential to have tremendous impacts on both the employees and the employer in a way that does not take away from the quality of the work. This research contains the following research question: is it possible for a 21st century CPA firm to be successful through employing a staff consisting solely of telecommuters?

The balance of this paper is organized and structured into four main sections that include subsections as well. First, there will be a literature review to bring in details from prior works to support this study and a theoretical framework to process the information presented in the literature review. Second will come a section on method, which will include the research question and the experiment design entailing the participants, procedures, and statistics. The next section will cover the findings of the research experiment. Last, there will be a section for the conclusion containing limitations and future research.

LITERATURE REVIEW

The accounting industry has been in existence for hundreds of years because it has adapted with the times and the development of technology (John & Thakur, 2021). Accounting has transitioned from being an in-home industry to more of a corporate industry. Likewise, the industry has shifted from the work being done mostly on paper and through written documents to the use of technology in the form of laptops and computer programs and software to increase efficiency and accuracy of the work accountants do (Mishra, 2021). Most of the work accountants do now is done on their laptops or other portable devices using documents provided by their clients while the accountants are at the client's location for an audit (Stimpson, 2004).

To stay up-to-date with the trends of the 21st century accounting firms and accounting departments operating entirely paperless from their office and only use paper when it is a client's document. In seeing the success of these companies who operate in a paperless fashion, and the known fact of the work accountants do in the office is done on a laptop, the idea of telecommuting and operating without an office has developed to contribute to the notion of work-life balance within the vigorous industry (Knight & Taylor, 2021). Having a better work-life balance is associated with having more ethical employees, and a key to being an accountant is being ethical and having integrity when completing work (Berk & Gundogmus, 2018).

Technology is changing the way accounting firms operate. Portable computers in the 21st century have altered the way accountants complete their work and when they complete their work. Laptops allow an accountant to do work from any place with an Internet connection: a flight, a client meeting room, or a waiting room outside a client's office (Stimpson, 2004). Cell phone, iPad, another other handheld devices have also made it possible for accountants to work outside the office. As accountants have learned new ways to take advantage of these abilities to become more efficient (Mishra, 2021).

Firms need to maintain client confidentiality. A challenge facing accountants with the wave and development of technology is to safely store data. The use of technology allows accountants to access their work from anywhere with the ability to connect to the Internet, but their work also has the potential to be stolen by others connected to the Internet, if it is not on a protected network. Virtual private networks or VPNs create the possibility for a secure network in public servers or spaces (Varvello et al., 2021). Despite some risk in using technology from various locations, they provide accountants with the advantages of flexibility, connectivity, portability, and their ease of use (Stanciu & Gheorghe, 2017).

In considering the way accountants use their technolgoy to complete their work comes to the opportunity of completing work outside the office at locations such as a home office (Peters, 2007). The idea of a flexible schedule has developed. A flexible schedule allows the employee to complete a set number of hours of work each week in the office while having several total hours required for work each week as well. For example, a company may need 30 hours of in-office work a week, but also require 40 total hours of work per week from their employees. This means that each employee has the option to complete up to 10 of their required hours at home or a coffee shop or another location of their choice (Alexander, Dijst, & Ettema, 2010; Lyons & Haddad, 2008). Frank and Lowe (2003) completed a study on accountants having the option to have a flexible schedule. The results show that employees who take advantage of flexible schedule often experience fewer promotions in comparison to their "in office" counterparts.

Other studies have also been completed on the idea of allowing employees to use a flexible schedule or flextime. When given the option for flextime, it is more common for employees to opt to take advantage of the option than to continue working a traditional schedule (Alexander, Dijst & Ettema, 2010). The performance and effects of an employee taking advantage of flextime align with that of the study completed by Frank and Lowe, but this study goes into detail about how the employees feel about flextime.

Employees who take advantage of the option for flextime are more satisfied employees, and they are willing to have a decreased salary to work on a flextime schedule (Church, 2015). This study also examines how managers feel about employees using flextime. The study shows that managers understand why employees opt for flextime, for a better work-life balance and more job satisfaction, and why employers offer flextime, to save money and decrease turnover, but they feel flextime decreases productivity and they miss the valuable face-to-face interaction.

Bednar (2010) investigates companies offering flextime, but at the discretion of the employee and their manager (Bednar, 2010). This means the employee can work from home if the manager agrees the employee can get their work done effectively even if the employee is not in the office. The positive effects of this change to flextime are like Church (2015) but expand this research to include managers benefits and employee benefits.

To take a step further away from operating from an office is the idea of telecommuting. Telecommuting is like the idea of flextime except usually no requirement for the time needed to be spent in the office each week like with flextime. Telecommuting allows employees to work from home or another convenient location, whenever they feel they can be productive when doing so (Abrams, 2019; Cox, 2009). Telecommuting has been proven to save employees up to 15 days' worth of a year of time spent commuting (Rapoza, 2013). Employees with more experience telecommuting tend to be more productive in doing so than those just beginning as telecommuters (Broman, 2014). Also, according to Broman, managers are more comfortable with managing telecommuters when there is an efficient teleconferencing system in place to get effective face-to-face time with employees not working in the office.

The traditional mindset of the accounting industry is one where the physical office space is dominant. But often long held stereotypes are inaccurate (Boylan, Mastriani & Boylan, 2018). Within the accounting industry, there are accountants operating individually whose practices are done from within their home. These accountants show the capability of an accountant to complete accurate work while doing so from a home environment. Accountants working from home excel in their ability to budget and decrease the need for various expenses while also maintaining their expertise in analyzing financial statements (Northcott & Doolin, 2008). In seeing the success of accountants working from home, and the benefits of options such as flextime and telecommuting, the idea of having a virtual office has been considered as a next step in developing the accounting industry. This alternative can be successful when the employees can be productive when working alone and do not need excessive guidance to complete their work (Drew, 2013).

Theoretical Framework

The traditional model for an accounting firm is to have a physical office. One where all the activities of the firm would take place and where all the records would be located. This was important to maintain client confidentiality. How and where accountants complete their work has developed in recent decades to adapt for employees who need more time at home and want a better work-life balance in an industry known for its busy seasons which includes long work weeks with little time for non-work-related interests. Firms have already implemented options such as flextime and telecommuting, with the use of laptops and the ability to work anywhere with an Internet connection allowing for these developments to be possible. In short, even before the COVID

disruption, firms were already moving away from a physical location. The next step in transforming the accounting industry may be to make the entire firm a virtual firm without using office space in any capacity. Considering all these changes researchers boldly asked the question: "does a firm need a physical location?" With such an unconventional idea, researchers looked at several well cited peer reviewed articles on the subject specifically in the accounting industry. The synopsis of these results was used to compare to the current business environment to draw a conclusion for discussion.

METHOD

The research focused on the employee, management, and the accounting firm. The purpose of this study is to determine if it is feasible for an accounting firm to be successful with all members of the firm operating at a location of their choice, without the firm possessing any office space. With the constant rise of and development of technology in the 21st century, the physical office has decreased in value in the accounting world as the work is done online using various programs.

The study is designed to account for the research question being one without data on actual results to answer it. Without the existence of accounting firms operating with no physical office, there is no evidence on the success or failure of this possibility. Therefore, the study was designed using existing examples and studies on firms using different approaches to employees completing their work using various ranges of means to do so in terms of how virtual each employee is. This includes employees operating on flextime, telecommuting, and individual accountants using their homes to complete work as opposed to an office building.

The participants for this study consist of secondary research. The following table shows them.

Table 1. *Five studies used to research the physical firm.*

Source Number	Title	Author	Year
1	"The Effect of Work-Life Balance on Accounting Ethics"	Cem Berk and Faith Gundogmus	2018
2	An Examination of Alternative Work Arrangements in Private Accounting Practice"	Kimberly Frank and Jordan Lowe	2003
3	"Gauging Perceived Benefits from 'Working from Home' as a Job Benefit"	Nicole Church	2015
4	"Telecommuting in the 21st Century: An examination of Managerial Attitudes"	Noel Broman	2014
5	"Working from 9-6? An Analysis of in-home and out-of-home working schedules"	Bayarma Alexander, Martin Dijst, and Dick Ettema	2010

This study was conducted by taking the data from the five studies listed in the previous table and analyzing how the previous results apply to this current study. This includes determining the significance and effects of a work-life balance, how managers feel about employees working from home, benefits of working from home instead of an office, and what a home schedule looks like compared to an office schedule. The current study addresses these areas to determine how blending the data may result in a firm operating without a physical office through a virtual office.

The research used secondary qualitative data to complete the study. This includes informative data as well. This study has the following research question: is a physical firm necessary for a 21st-century accounting firm? The null hypothesis, H_o, is a physical firm is necessary for a 21st-century accounting firm to operate effectively. H_o where F is a physical firm and Y is necessary: H_o: F = Y.

The alternative hypothesis, H_a, is a physical firm is not necessary for a 21st-century accounting firm to operate effectively. H_a, where F is a physical firm and Y is necessary: H_a: F ≠ Y.

RESULTS

This section will focus on the results produced by the five studies mentioned in the methodology portion of the study. Work-life balance is a topic to keep in mind when discussing accountants as accounting is known to be a profession requiring diligent work for long hours during certain parts of the year. The current study questions if it would be possible for a firm to operate while having all their employees work from a location of their choice when they are not required to be working at a client's location. The study conducted by Berk and Gundogmus (2018) confirms the importance of allowing employees to work from home whenever possible because of the positive effects of the relationship between a work-life balance and ethical behavior. Their study surveyed nearly 500 participants in the accounting industry in Turkey to compare how ethical they are as employees with how their work-life balances are. The results show 10.3% of the variance in ethical behavior can be explained by work-life balance, which is a significant figure (Berk & Gundogmus, 2018). With the figure being significant it confirms a relationship between work-life balance and ethical behavior for accountants, which is an industry relying on its ability to remain ethical for the good of all involved.

To further study how employees can better their work-life balance, a study by Bayarma Alexander, Martin Dijst, and Dick Ettema (2010) on working in-home and out-of-home was researched. Their study researches why employees prefer various work-hour arrangements, such as flexible options for start and end times of the workday, and the ability to work from home. The researchers had nearly 700 participants in completing their survey to provide them with details about where they spend their time working, in or out of an office, and the start and end times of their workday, and the frequency in which they completed work via ICT's (information and communication technologies) outside their normal work hours. The results of their study show that people of all backgrounds and job positions start and end at various times, but most people complete most of their work out-of-home. An interesting point made by the researchers about the flexibility of start and ends times has to do with the effects on travel and traffic. Here it is seen that more flexibility in those times decrease the time people spend traveling to work and the less traffic overall. The

results of their research also show that most in-home workers start later in the day compared to out-of-home workers. They also detail how many employees prefer the choice to vary their start and end times, and how older employees have more flexibility in their schedules than younger employees (Alexander, Dijst & Ettema, 2010).

The next article considered when evaluating if a firm could thrive without a physical office location involves a study completed by Frank and Lowe (2003) on the effects of work arrangements. The various work arrangements included and evaluated in their study are a traditional schedule, such as a 9-5 schedule, flextime, and telecommuting. They surveyed 160 employees in total with at least 50 working each work arrangement. The participants had an average of over 11 years of accounting experience, and they came from over 90 companies. The study attempted to determine if work arrangement affected performance, commitment and dedication, recognition of work, and difficulty of work assignments. The relevance to the study is the results of performance and commitment. The results of this study show no impact of work arrangement on performance or job commitment. However, there were comments made by managers who were surveyed stressing the importance of face-to-face communication for productive results. The results also included the negative affects of flextime and telecommuting on long-term potential for employee advancement, development, and projected future performance (Frank & Lowe, 2003).

Another study was conducted to evaluate if the perceived benefits of working from home are accurate. Church (2015), the conductor of the study, evaluated both employees and managers working from home in many business-related industries including accounting. A survey was given asking for responses on a scale of 1-5 with 1 equating to strongly disagree and 5 equating to strongly agree on questions about working from home: more productive working from home, improved job satisfaction, employer saves money, strong promotional opportunities, ability to preserve work/life balance, ability to work on team assignments, high motivation, and miss face-to-face interaction. The results show most employees are productive, motivated, and maintain their ability to manage a work-life balance and work on teams. However, promotional opportunities do not remain strong and many employees surveyed do miss face-to-face interaction. Church also details what managers find useful for there to be metrics to evaluate employees who work from home. These include the employees ability to prove their production in some way and increase trust between employees and managers (Church, 2015). The managers' opinions of working from home and the effects on the employee from working from home are significant to this study.

To further research managers' attitudes towards telecommuting for the current study, Noel Broman's (2014) research on attitudes towards telecommuting was investigated. She surveyed over 150 managers at various companies with different job descriptions. Telecommuting is becoming more common as a business strategy because of the benefits to employees and their organizations which include cutting costs, increased productivity, creativity, and success. This research concludes there are two reasons that have significant effects on whether telecommuting can have success: the number of years of experience with telecommuting and teleconferencing capabilities. It was proven to be statistically significant for employees to be more motivated when telecommuting for over ten years than for 1-5 years. Also, the ability to teleconference effectively was correlated with a higher average of perception of professional interaction and perception of the ability for employees to work effectively from home, meaning managers are more satisfied with these employees. Also, years of experience with telecommuting was found to correlate to the

effectiveness of the security of confidential information (Broman, 2014). Each of these conclusions has significant impacts on the feasibility of having an accounting firm exist where theoretically the entire company operates on a telecommuting schedule.

Table 2. *The effects of employees working outside the office.*

Variables	Advantage	Neutral	Disadvantage	Source (from Table 1)
Cost	X			1,2,3,4,5
Face-to-face Communication			X	2,3,4,5
Ethical Practice	X			1,3,4
Enhanced Work-Life Balance	X			1,2,3,4,5
Performance		X		1,3,4,5
Commitment		X		3,4,5
Creativity	X			1,3,4
Teamwork	X			1,2,3,5
Job Satisfaction	X			1,2,3,5
Employee Development			X	1,3,4,5
Employee Advancement			X	2,3,4

The Table above summarizes the results of the five studies researched. Each X represents the effect an employee working from outside the office during work hours has on either themselves, management, or the firm. For example, the X in the advantage column for the cost variable means that working from outside the office is an advantage about employee costs. It can be seen there are six items labeled as "advantages." Also, three items are disadvantages and two items that are neutral (neither an advantage or a disadvantage).

Each of the findings from the five previous studies will be pulled together to evaluate if a physical firm is necessary for 21st-century accounting. The next portion of this study will conclude on the relevance of each study to the current research and dissect how not having a physical location would affect employees, managers, and the company based on performance, commitment, productivity, managerial ability, advantages, and disadvantages.

CONCLUSIONS

This research takes prior studies conducted regarding how other organizations have experienced employees working on different forms of scheduling and work arrangements. It examined how working out of the office affects the firm, management, and employees. Reviewing the null and alternative hypothesis from the methodology section, conclusions can be drawn from the findings section of the current research on the previous studies to answer the research question: is a physical firm necessary for 21st-century accounting?

In total, the research concluded it is not necessary for a 21st-century accounting firm to have a physical office location. This is a result drawn from evaluating information provided in the five studies closely researched in the findings section. The research question asks if a physical firm is necessary. This leaves open the possibility having a physical firm could possibly be more beneficial than a virtual office format. Flexible schedules themselves are not a conduit for cost

savings as rent and general utilities would still incur even with a reduced staff. Cist saving could occur if the firm could mix the two options and reduce the number of days employees need to report to the office.

The findings section shows four main conclusions. First, having no physical firm would contribute to a better work-life balance for the employees because of having the capacity to work from home whenever they are not scheduled to work at a client. As presented in the findings section, a better work-life balance contributes to the likelihood of ethical behavior. Therefore, an accounting firm operating without a physical office is more likely to work ethically.

A second conclusion drawn from the findings relates to the performance and commitment of employees. Research showed management was concerned with employee performance when schedules are changed either by location or time. This means employees working from various locations or on flextime are equally likely to perform well and remain committed to the firm. This supports the conclusion that a physical firm is not necessary.

A third conclusion from the research is the cost effects of eliminating a physical firm. A firm operating without office space will save the cost associated with owning or renting office space. Firms that offer for employees to work from home either through flextime or telecommuting experience lower rates of employee turnover, which saves the firm financially from the cost associated with hiring and training new employees. These finances can then be funneled back into the company for various other needs.

The last conclusion developed by the research is the challenges involved in not having a physical location. Several studies emphasized face-to-face interaction is significant between managers and employees. Removing the physical location would also negatively impact daily face-to-face interaction between employees and managers. One study relayed the importance for telecommuters to teleconference with managers and other employees as needed to replace the face-to-face communication.

To answer the research question, no, a physical firm is not necessary for 21st-century accounting. Eliminating the physical office to use a virtual office provides enough benefits to employees, managers, and the entire firm. It is possible for a firm to operate without a physical location despite some of the potential challenges that may face managers and employees in doing so.

Implications for the Profession

This current study can be applied to accounting firms across the globe. Firms can evaluate the advantages and disadvantages associated with operating without a physical location to determine if that option may be a possibility for their firm that may set them apart from their competition to gain a competitive advantage. In the most likely event, reducing rather than eliminating an office location. This could meet both the benefits of cost savings while providing a physical platform for physical space needs.

Research Limitations

This research was limited because no existing accounting firms operating with no physical location now. Therefore, no research could be done on actual results of not having a physical location and there were no prior studies done on this same topic as well. The research was done on situations including similar characteristics to those of a potential virtual office, but no data was collected from existing situations.

Future Research

This study has built an understanding from many other studies and should serve as an engine for future research. Future research can be done in two different ways. One way is for a researcher to survey managers and employees of successful virtual accounting firms. This would be done to evaluate what the feasibility of non-physical opinions would be and to determine feasibility. Another matter for future research could be the impact of changing from a physical firm to a virtual office. Here researchers would look at the effects of a switch on employees and operational efficiency.

REFERENCES

Abrams, Z. (2019). The future of remote work: When it is done right, telework can improve employee productivity, creativity and morale, psychologists' research finds. *American Psychological Association, 50*(19). 1-54. Retrieved from https://www.apa.org/monitor/2019/10/cover-remote-work

Alexander, B., Dijst, M., & Ettema, D. (2010). Working from 9 to 6? an analysis of in-home and out-of-home working schedules. *Transportation, 37*(3), 505-523. doi:http://dx.doi.org/10.1007/s11116-009-9257-1.

Bednar, J. (2010). Beyond the 9-to-5. *BusinessWest*, 26(21), 18. Retrieved from https://businesswest.com/blog/beyond-the-9-to-5/

Berk, C., & Gundogmus, F. (2018). The effect of work-life balance on accounting ethics. Retrieved from https://www.econstor.eu/handle/10419/179998

Boylan, D. H., Mastriani, A. J. & Boylan, C. L., (2018). Defending professionalism: Exploring accounting stereotypes in American movies. *Quarterly Review of Business Disciplines, 5*(2), 103-116. ISSN 2334-0169.

Broman, N. C. (2014). Telecommuting in the 21st century: An examination of managerial attitudes (Order No. 3610248). Retrieved from https://eric.ed.gov/?id=ED566063

Case Studies: Outsourced accounting; Three firms share their experiences as "virtual accountants." (2013). *Accounting Today, 27*(11), 36–36.

Church, N. F. (2015). Gauging perceived benefits from 'working from home' as a job

benefit. *International Journal of Business and Economic Development, 3*(3) Retrieved from https://ijbed.org/cdn/article_file/content_80934_18-02-25-11-43-47.pdf

Cox, W. (2009). Executive summary: Improving quality of life through telecommuting. Retrieved from http://www.itif.org/files/Telecommuting.pdf

Drew, J. (2013). How to open new doors by closing your office. *Journal of Accountancy, 216*(1), 24-27,29,8. Retrieved from https://www.journalofaccountancy.com/issues/2013/jul/20126676.html

Frank, K. E., & Lowe, D. J. (2003). An examination of alternative work arrangements in private accounting practice. *Accounting Horizons, 17*(2), 139. doi:http://dx.doi.org/10.2308/acch.2003.17.2.139.

John, J. & Thakur, R. (2021), Long term effects of service adaptations made under pandemic conditions: the new "post COVID-19" normal. *European Journal of Marketing, 55*(6), 1679-1700. https://doi.org/10.1108/EJM-08-2020-0607.

Knight, M. E., & Taylor, R. M. (2021). A word of caution to students: Public accountant perceptions of alternative work arrangements. *Issues in Accounting Education, 36*(3), 29-47. https://doi.org/10.2308/ISSUES-2020-022.

Lyons, G., Haddad, H. (2008). An exploration of demographic, work, home and commute aspects of part-day and whole-day homeworking. In: 4th International Specialist Meeting on ICT, Everyday Life and Urban Change, Bristol, UK.

Mishra, D. P. (2021). COVID-19 Disruption and service firms' adaptation strategies: Institutional theory perspectives. The future of service post-COVID-19 pandemic. *Transformation of Services Marketing,* 2, 175-203. Retrieved from https://link.springer.com/chapter/10.1007%2F978-981-33-4134-0_8

Northcott, D., & Doolin, B. (2008). Qualitative research in accounting & management – the journey so far. *Qualitative research in Accounting & Management,* 5, 5-10. doi:http://dx.doi.org/10.1108/11766090810856732.

Peters, K. (2007) m-Learning: Positioning educators for a mobile, connected future, International Review of Research in Open and Distance Learning, 8(2). 1-17. https://doi.org/10.19173/irrodl.v8i2.350.

Pickard, M. D., Schuetzler, R., Valacich, J. S., & Wood, D. A. (2020). Innovative accounting interviewing: A comparison of real and virtual accounting interviewers. *The Accounting Review, 95*(6), 339–366. https://doi.org/10.2308/tar-2017-0235

Rapoza, K. (2013). One in five Americans work from home, numbers seen rising over 60%. Forbes. Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/350.

Stanciu, V., & Gheorghe, M. (2017). An exploration of the accounting profession – the stream of mobile devices. *Accounting and Management Information Systems, 16*(3), 369-385. doi:http://dx.doi.org/10.24818/jamis.2017.03007

Stimpson, J. (2004). Accountants and their laptops. *The Practical Accountant, 37*(3), 32-35. Retrieved from http://0-search.proquest.com.libcat.widener.edu/docview /208244412?accountid=29103

Varvello, M., Azurmendi, I. Q., Nappa, A., Papadopoulos, P., Pestana, G., & Livshits, B. (2021). VPN-Zero: A privacy-preserving decentralized virtual private network. *2021 IFIP Networking Conference (IFIP Networking),* 1–6. https://doi.org/10.23919/IFIPNetworking52078.2021.9472843.

Vera-Mun˜ oz, S. C., Ho, J. L., & Chow, C. W. (2006). Enhancing knowledge sharing in public accounting firms. *Accounting Horizons, 20*(2), 133-155. https://doi.org/10.2308/acch.2006.20.2.133.

Wang, B., Liu, Y., Qian, J., & Parker, S. K. (2020). Achieving effective remote working during the COVID-19 pandemic: A work design perspective. *Applied psychology = Psychologie appliquee*, 10.1111/apps.12290. Advance online publication. https://doi.org/10.1111/apps.12290.

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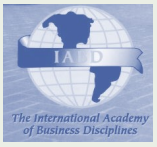

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