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# The Productivity Impact of New Technology: Evidence from the US Retailers Industry

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**ABSTRACT**

**This study determines how information technology impacts selected retailers' overall financial productivity. To measure the impact of information technology on productivity in the retail industry, a purposive sample of five retailers' technological innovation and financial performance was collected and analyzed. Five retailers were selected from a list of the most prevalent retailers in the U.S.: Starbucks, Target, Verizon Wireless, Ulta Beauty, and Build-A-Bear Workshop, Inc. The linear regression with analysis of variance performed revealed a weak or insignificant relationship between information technology usage and productivity as measured by retailer revenue.**

**Keywords:** Information technology, retail store, financial productivity, impact of technology

## INTRODUCTION

### Technology in Retail Industry

Prior research has shown the overall importance of technology adoption in improving competitive advantage by increasing efficiency, promoting innovation, and refining customer satisfaction (Cozzrin, 2010) (Hamilton, 2008) (Melville, 2004) (Powell, 1997) (Romero & Martinez-Roman, 2015) (Vinekar, 2012) (Watson, 2011). When companies improve their technological innovations, they are better situated to capture consumer behaviors, assess customer satisfaction, and obtain the most accurate and up to date information on customer needs and expectations (Romero & Martinez-Roman, 2015). However, despite its benefits, retail store adoption of information technologies has been mediated by uncertainty, customer acceptance, and cost of investment (Romero & Martinez-Roman, 2015). Even further, the ownership's influence is also found to impact whether retail store adopts new technologies in their store operations (Romero & Martinez-Roman, 2015). Most businesses will only adopt a new technology that has already been in use by other stores in their similar industry and category of sales (Romero & Martinez-Roman, 2015). It is believed that information technology add the most value for their customers when it has been reasonably and realistically employed by similar businesses (Romero & Martinez-Roman, 2015). Moreover, the value of introducing new information technologies is further impacted by "their capacity to improve the sales process from different points of view—customers, suppliers, distributors, workers, etc." (Romero & Martinez-Roman, 2015) p. 648).

Some of the most well received technological innovations include those that improve the work carried out in store and those that satisfy customers' interests, such as interactive touch screens in store, mobile applications, and automatic payments that allow bypassing of checkout lines (Romero & Martinez-Roman, 2015). The value of information technology and its ability to improve an organization's performance is dependent on the type, including required systems and processes that must be incorporated or developed, organizational structure and facilities, management practices, as well as other macro environmental factors (Melville, 2004).

The current study will seek to understand how information technology impacts selected retailers' overall financial productivity.

In their study of 162 manufacturing and service firms, Dasgupta, Sarkis, and Talluri (Dasgupta, Sarkis, & Talluri, 1999) explored whether technology investments significantly and directly impact productivity. Their initial review uncovered that information technology reduce production costs, lower average total costs, and increase average overhead costs (Dasgupta, Sarkis, & Talluri, 1999). Information technology investments can be categorized into their various components: capital, budget, client-server expenditure, information systems staff expenditure, hardware expenditure, software expenditure, and telecom expenditure, with research findings that all components have a positive effect on sales as the output variable, with only capital and client-server expenditure positively effecting performance overall (Dasgupta, Sarkis, & Talluri, 1999). Even further research has limited information technology investments to an optimal level of 20 to 25 percent of total operating expenses with the effect of reducing operating expenses over time (Dasgupta, Sarkis, & Talluri, 1999). Research conducted by Cozzarin and Percival (Cozzrin, 2010) and Ko, Clark, and Ko (Ko, 2008) corroborated these findings that each industry experiences a threshold at which the amount of information technology investment will improve productivity, after which additional investments either stagnate or actually decrease productivity.

**Retail stores and their use of technology in store**

Technology use in retail stores can be divided into three broad categories based on their characteristics: touch screen displays, mobile applications, and hybrid systems (Romero & Martinez-Roman, 2015). Touch screen displays are most useful at point of sale in that they allow for the utilization of self-service technologies, like automatic payments, virtual dressing rooms, product searches, and self-service check-out (Romero & Martinez-Roman, 2015). Mobile applications are a free application downloaded to a mobile device that allows the same experience as touch screen displays, but achieved through a remote location with additional personalization available, like customer accounts. Finally, hybrid systems combine technologies which retail stores use in their store operations and those which customers use both inside and outside of the retail location (Romero & Martinez-Roman, 2015)

Furthermore, there are five views of information technology: tool view, proxy view, ensemble view, computational view, and nominal view, which conceptualize IT as an artifact of business information systems and technologies (Melville, 2004). In the proxy view, IT is defined in terms of its perceived usefulness, its diffusion within the business system, and the financial investments involved in its dissemination (Melville, 2004). This research will focus on the proxy view, which incorporates organization's financial information in its operationalization of information technologies impact on productivity and performance.

***Types of Technology***

In their study of the five largest retailers in the U.S., Powell and Dent-Micallef (Powell, 1997) documented the most utilized technologies within the retail industry. Their survey found that retailers use information technology throughout every aspect of their organization's processes, from manufacturing, suppliers, and warehousing to distributions, inventory management, and sales (Powell, 1997). Some of the information technologies used in the retail industry include distribution center scanning, inventory management, electronic invoicing, electronic shipping notices, electronic funds transfers, customer databases, satellite communications through fax and email use, inventory data sharing, and point of sale scanning, human resource management, and marketing (Drennan & McColl-Kennedy, 2003) (Powell, 1997). There are numerous ways that retailers utilize information technologies before the consumer even

enters their store. However, for the purposes of this research, those technologies that directly influence the customers experience inside the retail store will be the focus of our analysis.

**Different measures of Retail Productivity**

Researchers have been careful to delineate productivity as a different concept from other interchangeable terms, like efficiency and effectiveness (Wu, Kao, Wu, & Cheng, 2006). Whereas productivity is concerned with inputs and outputs, efficiency measures the effects of all inputs and effectiveness factors in goals reached or benchmarks achieved (Wu, Kao, Wu, & Cheng, 2006). Productivity is often further defined as performance, which can be categorized according to six dimensions: 1) competitive performance, such as market or segment shares and growth; 2) innovation dealing with innovative processes and outputs; 3) quality of service, which includes retailer response, reliability, and product or service availability; 4) flexibility, referring to delivery and volume of merchandise available; 5) resource utilization which includes productivity and efficiency in its measurement; and finally, 6) financial performance, which includes sales, profitability, and capital structure (Wu, Kao, Wu, & Cheng, 2006) p. 84). Similar measures of productivity have proposed that an organization's performance be measured as a composite score based on sales per square foot, cash flow management, cost containment, sales per employee, net income after taxes, total sales growth over a specified time period, and overall store success (Wu, Kao, Wu, & Cheng, 2006).

Additionally, productivity is also defined as the "ratio of output to input" in the measurement of "key performance indicators" (Mishra & Ansari, 2013), p. 348). Simplified even further, productivity "deals primarily with the relation between a single input and an output measure, given other inputs constant" (Wu, Kao, Wu, & Cheng, 2006)p. 84). Outputs are defined simply as sales, or more specifically as "the availability of items/merchandise." (Mishra & Ansari, 2013) p. 354. Inputs are identified as labor, capital, retail merchandise for sale, store interior, systems and processes, IT, and point of sales (Mishra & Ansari, 2013). Inputs are the independent variables with some control variables, like consumer characteristics or type of retail store, and outputs are the dependent variables. Researchers have found that productivity is usually measured using partial productivities, like labor productivity, employee turnover, capital productivity, sales per square feet, return on investment, or information technology productivity (Mishra & Ansari, 2013) p. 348). Additional divisions of input factors include environmental conditions, like national economy and industry technology level, customer factors, such as shopping time or income level, managerial efforts, including inventory investment and assets, and employees personal factors, like wage rate and hours worked (Wu, Kao, Wu, & Cheng, 2006). Simplifications of measuring retail productivity have also narrowed the inputs down to four variables, store size, store manager experience, store location, and promotion expense, and two outputs, sales and customer satisfaction (Wu, Kao, Wu, & Cheng, 2006). This research will focus on the following key performance indicators of productivity as outputs: sales and assets. Capital expenditures will also be factored in as an additional control variable. The inputs in this research will be the types of technology offered by each retailer.

***Calculating Retail Productivity***

Some of the more common methods of calculating retail productivity include utilizing executive opinion surveys, ratio analysis, data envelopment analysis (DEA), structural equation modeling, linear regression modeling, multiple regression modeling, or the Cobb-Douglas model, which is a type of multiple regression (Anand & Grover, 2015) (Dasgupta, Sarkis, & Talluri, 1999) (Drennan & McColl-Kennedy, 2003) (Hamilton, 2008) (Ko, 2008) (Kohli & Devaraj, 2003) (Mishra & Ansari, 2013) (Powell, 1997) (Vinekar, 2012) (Wu, Kao, Wu, & Cheng, 2006).Melville, Kraemer, & Gurbaxani (Melville, 2004) proposed an IT business value model grounded in the resource-based theory that posits organizational performance is

impacted by business process performance directly, which is influenced by information technology, combined with human resources and organizational resources, with the industry characteristics and trading partners having an indirect influence on the organization as a whole. (p. 293). This model also proposes differentiating between whether the information technology improves operational efficiency or competitive advantage in identifying its business value (Melville, 2004) (Powell, 1997) (Vinekar, 2012). Here, information technologies value is parsed through its impact on the organization's business practices and thus their performance and productivity overall. This relates to the current research in that the business practices of investing in information technology and maintaining assets are byproducts influencing the level of productivity as a result of information technology usage.

In their study, Wu, Kao, Wu, and Cheng (Wu, Kao, Wu, & Cheng, 2006) used DEA to determine retail performance using financial indices to further investigate their effect on inputs and outputs. Their results showed that retail performance as indicated by sales and gross margins were significantly related to current assets, the number of employees, and promotion expenses; however inventory investments showed no impact on sales or gross margins (Wu, Kao, Wu, & Cheng, 2006).

Mishra and Ansari (Mishra & Ansari, 2013) proposed a complete productivity model which takes into consideration the inputs and outputs with empirical store-level data. Their model factors in the outputs, merchandise, services, and value, and the inputs, labor, capital, merchandise, store interiors, IT and systems and processes (Mishra & Ansari, 2013), p. 349). Their model sought to focus on all independent parameters impacting retail productivity as an exhaustive method that is based on individual retail stores rather than stores across the country in an effort to improve store-level performance (Mishra & Ansari, 2013). This research will attempt to partially replicate their research by focusing on stores at the aggregate, national-level.

Using the DEA model in combination with other computational models, Dasgupta and their fellow researchers (Dasgupta, Sarkis, & Talluri, 1999) evaluated information technology budget and information technology employees as inputs and net income as the output to uncover the productivity of firms in relation to their IT expenditures. Their results showed that manufacturing firms in the low investment group had the highest productivity and firms in the high investment group had the lowest productivity (Dasgupta, Sarkis, & Talluri, 1999). However, the same analysis showed information technology had no significant effect on performance for firms in the service sector. Based on these results, Dasgupta and their colleagues (Dasgupta, Sarkis, & Talluri, 1999) concluded that technological investment had a negative or null impact on firm performance in both manufacturing and service industries. This indicates that other measures of productivity which factor in customer satisfaction and customer loyalty might be additional inputs to consider in determining how information technology impacts retail industry productivity and performance. Similarly, Powell and Dent-Micallef's (Powell, 1997) study of the five largest retail stores in the U.S. indicated that information technology alone did not account for the retailers' financial performance. Their research attributed significant impact on financial performance to complementary human resources utilized in conjunction with the information technologies (Powell, 1997). This research seeks to confirm or disprove their conclusions based on a different, U.S. based sample of retailers.

## METHODS

To address the impact of information technology on productivity in the retail industry, a purposive sample of five retailers' technological innovation and financial performance will be

collected and analyzed. Five retailers were selected from a list of the most prevalent retailers in the U.S.: Starbucks, Target, Verizon Wireless, Ulta Beauty, and Build-A-Bear Workshop, Inc. The number of the sample was limited to five so as to allow for in-depth data collection and a simplified analysis of variance across multiple comparisons. In terms of the products each retailer sells, Starbuck's sells beverages, food, packaged and single-serve coffees and teas, ready to drink beverages, server ware, and coffee-making equipment (Starbucks, 2016). Target sells household essentials, apparel and accessories, food, pet supplies, home furnishings and décor, electronics, music, movies, books, computer software, sporting goods, and toys (Target, 2017) . Verizon sells wireless services and wireless devices, like smart phones, basic cell-phones, tablets, and other Internet devices (Verizon, 2017). Ulta sells beauty products, like cosmetics, hair care products, salon styling tools, skin care products, fragrances, nail care products, and salon services (Beauty, 2017). Build-A-Bear Workshop Inc. sells stuffed toys and accessories (Inc., 2017). These retailers were selected based on the variability of their physical product offerings and the online availability of their financial performance in the form of SEC filings. Revenues, or sales, for each retailer were used to calculate their financial performance. Other financial data were also collected including capital expenditures, the amount spent on information technology, and total assets.

Other reasons for the five retailers selected in the purposive sample include their national presence at multiple stand-alone, shopping center, and shopping mall locations with store locations numbering greater than 1,000 across the U.S. Each retailer will be scored according to their use of information technology in-store as indicated by the presence of the selected technologies: self-service or mobile point of sale/transactions, websites facilitating online sales, mobile applications, and loyalty rewards cards or online customer accounts. Each retailer will receive one point for each of the information technologies present and available for consumer use as a means of purchasing products. The information technology will not be counted in the technology score if it does not enable consumer purchases of the retailed goods. Finally, the technology score will be compared to the three financial performance indicators using SPSS for descriptive and statistical analysis along with linear regression and analysis of variance with a standard significance level($p =< 0.05$). Retailers with a high technology score, 4, and high financial performance will be considered high productivity, while retailers with a low technology score, 2 or below and a low financial performance will be considered low productivity. Low financial performance is defined in comparisons of the five retailers as well as intra-related retailer trends.

## RESULTS

A multiple linear regression with a two-way analysis of variance was performed with the technology score as the independent variable and each retailer's revenue over a three-year period as the dependent variable. An initial review of the data revealed that Verizon Wireless had the highest average revenue with a mean of over 121 trillion, and an average technology score of 3. Starbucks, the retailer with the highest technology score, a 4, had the third highest average revenue of almost 15 trillion. The retailer with a 2, the lowest technology score, Build-A-Bear Workshop Inc, also had the lowest average revenue, just over 384 million. Additional statistical analysis revealed that technology score accounted for just over nine percent of variance between the retailers($R = .09658$). Technology score accounted for even less variance when analyzed in terms of capital expenditures and assets, ($R = .00931; R = .03356$) respectively. In terms of statistical significance, the p-level was much higher than the standard at. 73204, indicating an insignificant or weak relationship between the independent and dependent variables. Further comparisons and regressions between the variables, including an F-test and additional ANOVAs only replicated this lack of significance between retailer technology use and productivity as financial performance.

**Table 1. ANOVA of IT score (X) and revenue (Y)**

**Y (Revenue) = 2.04652E+10 + 7,247,856,000 * X (IT Score)**

**ANOVA**

| | *d.f.* | *SS* | *MS* | *F* | *p-level* |
|---|---|---|---|---|---|
| *Regression* | 1 | 3.15E+20 | 3.15E+20 | 0.1224 | 0.73204 |
| *Residual* | 13 | 3.35E+22 | 2.57E+21 | | |
| *Total* | 14 | 3.38E+22 | | | |

| | *Coefficient* | *Standard Error* | *LCL* | *UCL* | *t Stat* | *p-level* | *H0 (5%)* |
|---|---|---|---|---|---|---|---|
| **Intercept** | 2.05E+10 | 6.35E+10 | -1.17E+11 | 1.58E+11 | 0.32221 | 0.75242 | *accepted* |
| **X (IT Score)** | 7,247,856,000.00 | 2.07E+10 | -3.75E+10 | 5.20E+10 | 0.34986 | 0.73204 | *accepted* |
| *T (5%)* | 2.16037 | | | | | | |

*LCL - Lower value of a reliable interval (LCL)*

*UCL - Upper value of a reliable interval (UCL)*

**Table 2. ANOVA of IT score (X) and capital expenditures (Y)**

**Y (Expenditures) = 1.69885E+10 + 520,129,833.33333 * X (IT Score)**

**ANOVA**

| | *d.f.* | *SS* | *MS* | *F* | *p-level* |
|---|---|---|---|---|---|
| *Regression* | 1 | 1.62E+18 | 1.62E+18 | 0.00113 | 0.97372 |
| *Residual* | 13 | 1.87E+22 | 1.44E+21 | | |
| *Total* | 14 | 1.87E+22 | | | |

| | *Coefficient* | *Standard Error* | *LCL* | *UCL* | *t Stat* | *p-level* | *H0 (5%)* |
|---|---|---|---|---|---|---|---|
| **Intercept** | 1.70E+10 | 4.75E+10 | -8.56E+10 | 1.20E+11 | 0.35772 | 0.72629 | *accepted* |
| **X (IT Score)** | 520,129,833.33 | 1.55E+10 | -3.29E+10 | 3.40E+10 | 0.03358 | 0.97372 | *accepted* |
| *T (5%)* | 2.16037 | | | | | | |

*LCL - Lower value of a reliable interval (LCL)*

*UCL - Upper value of a reliable interval (UCL)*

**Table 3. ANOVA of IT score (X) and assets (Y)**

**Y (Assets) = 4.51269E+10 + 4,981,505,500 * X (IT Score)**

**ANOVA**

| | *d.f.* | *SS* | *MS* | *F* | *p-level* |
|---|---|---|---|---|---|
| *Regression* | 1 | 1.49E+20 | 1.49E+20 | 0.01466 | 0.90549 |
| *Residual* | 13 | 1.32E+23 | 1.02E+22 | | |
| *Total* | 14 | 1.32E+23 | | | |

| | *Coefficient* | *Standard Error* | *LCL* | *UCL* | *t Stat* | *p-level* | *H0 (5%)* |
|---|---|---|---|---|---|---|---|
| **Intercept** | 4.51E+10 | 1.26E+11 | -2.27E+11 | 3.18E+11 | 0.3577 | 0.72631 | *accepted* |
| **X (IT Score)** | 4,981,505,500.00 | 4.11E+10 | -8.39E+10 | 9.39E+10 | 0.12106 | 0.90549 | *accepted* |
| *T (5%)* | 2.16037 | | | | | | |

*LCL - Lower value of a reliable interval (LCL)*

*UCL - Upper value of a reliable interval (UCL)*

**Figure 1. Linear Regression IT score (X) and revenue (Y)**

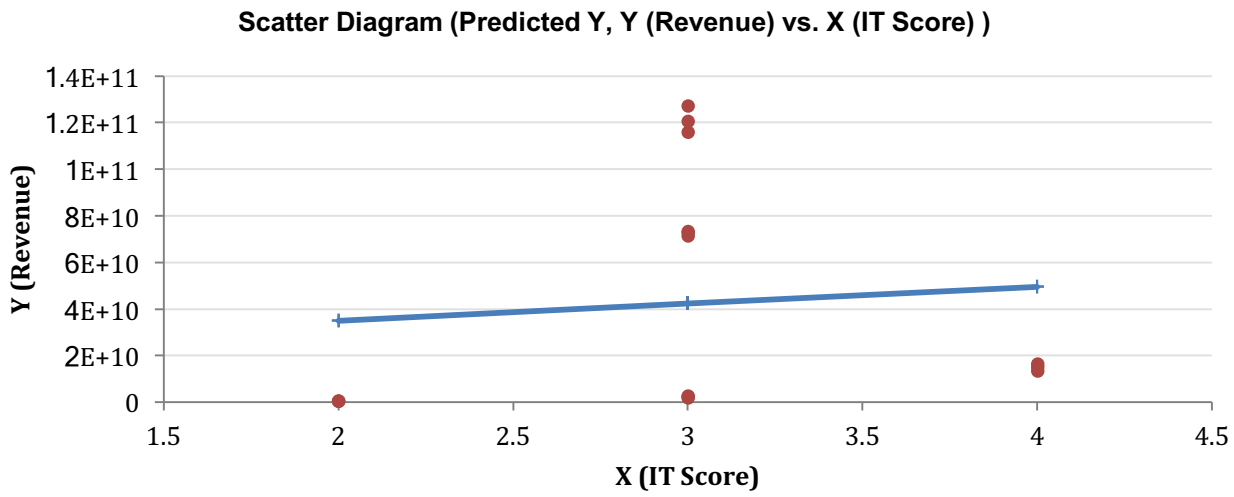


**Figure 2. Linear Regression IT score (X) and capital expenditures (Y)**

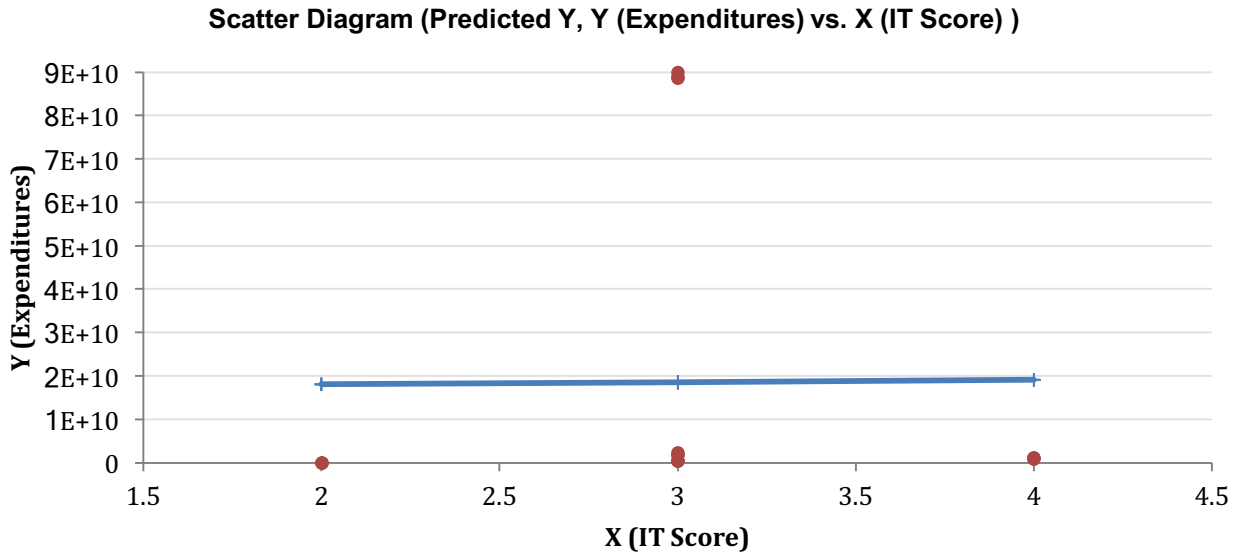
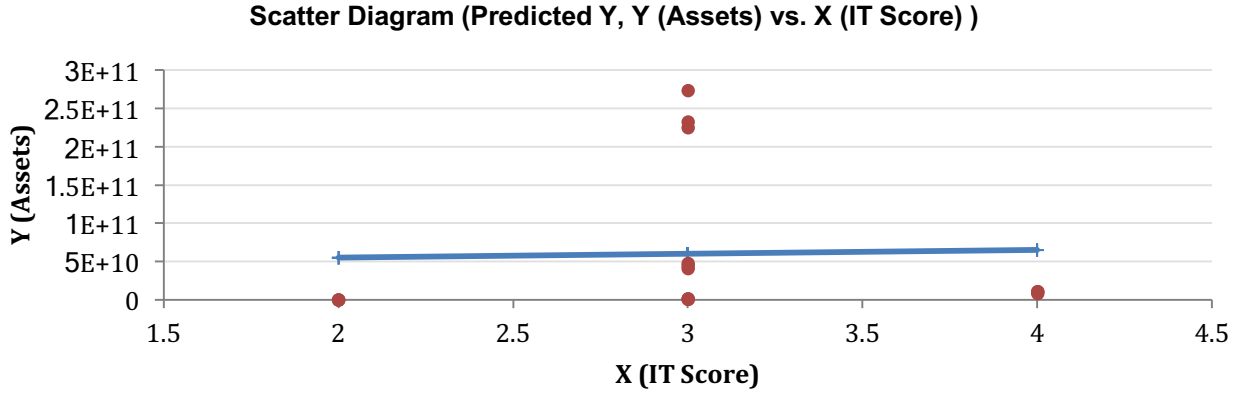



**Figure 3. Linear Regression IT score (X) and assets (Y)**




## DISCUSSION

Similar to the previous research, the linear regression with analysis of variance performed revealed a weak or insignificant relationship between information technology usage and productivity as measured by retailer revenue (Cozzrin, 2010) (Dasgupta, Sarkis, & Talluri, 1999) (Ko, 2008). This indicates that technology use does not influence productivity directly. The results did seem to confirm that minimal usage of technological innovation would result in lowered productivity, as seen with the Build-A-Bear Workshop Inc. retailer, but this was not a statistically significant assertion. However, the retailer with the highest technological innovation as indicated by their technology score, Starbucks, did not have the highest financial performance in terms of their revenue. This corroborates Dasgupta and their colleague's research, which stresses that information technology, will have a differential impact on productivity depending on the industry. Finally, each of the researchers suggested adding in additional dependent variables to measure productivity beyond revenue, such as customer satisfaction or store location, which would enable additional analysis of variance and comparisons to identify those factors beyond sales that information technology might impact. (Cozzrin, 2010) (Dasgupta, Sarkis, & Talluri, 1999) (Ko, 2008). This research contributes to the literature by replicating their prior research within the U.S. retail industry and confirming the lack of significant correlation between technology and productivity. Future research could attempt to engage in an exhaustive analysis of all possible variables as outputs and inputs

within each of the retailers to determine other factors that increase the statistical significance between information technology and productivity as indicated by financial performance.

## LIMITATIONS

This study is limited by the small sample size and the lack of an exhaustive measurement of all possible inputs and outputs mediating the relationship between information technology and productivity.

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