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**Electrifying Retail Future: Employee Perception on Implementing
Electronic Shelf Labels**

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Abstract

Automation is continuously changing the future of retail and reshaping business operations. The present study investigates employee perspectives on Electronic Shelf Labels [ESL] in a setting in which this technology has not yet been implemented. The survey was administered in electronic and paper format, obtaining data on participants' job positions, and the perceived usefulness of using systems. Participants were employees who are currently employed or have been employed in any type of retail store in Dubrovnik area. Findings suggest that employees are overall open to the implementation of such technology in their workplace. Performance expectancy of particular job duties appears to have no relation to the store size. Surprisingly, a high number of participants are positive in terms of usage of ESL although this technology is still not used by Croatian retailers. This solution provides employees with assistance in fulfilling their job duties timely and efficiently.

Keywords: electronic shelf labels, employee perception, retail automation, e-paper technology

What are Electronic Shelf Labels?

Digitalization has influenced the retail sector to incorporate many interactive technologies into their business (Soutjis, 2017). The evolution of price tags starts from individually adjustable prices, which allowed price negotiation between retailers and clients. The four generations of price devices, introduced in the early 20th century, aimed to master price-fixing. The first was handwritten price cards used predominantly in shop windows and later complemented with “clamping tags, swing tags, and price tag moldings” in the 1920s (Soujtis, 2017, p. 298).

Further advancement in the retail sector continued with digital innovation and the introduction of checkout scanners, Point of Sale [POS] software, e-catalogs, e-commerce, etc., and now almost every business regardless of the industry uses the QR codes accessible through smartphone apps (Soutjis, 2017). As a result of technological developments which are aimed toward tracking customers purchasing journeys, an increasing number of retailers have started to implement electronic shelf labels [ESL] – a technology that provides customers with “the online shopping experience offline” (Boden, Maier & Dost, 2020, p.4; Solomon & Deeter-Schmelz, 1993). The first time this relatively new technology of electronic labels was introduced was in the United States in 1985 (Solomon & Deeter-Schmelz, 1993).

The growth rate of this technological revolution in retail justifies the relevance of ESL implementation in the future of doing business. According to the research done by Meticulous Research, the electronic shelf label market is expected to reach a worth of \$2.57 billion by 2028 (Bombe, 2021). The research argues that the growth of the ESL market is fueled by the awareness of the environmental impact and importance of reducing paper waste, and also by the need for retail automation.

The ESL uses wi-fi for data updates and batteries as a way of power (Barasljevska, 2019). In simple terms, once the management adjusts the price, the update is sent to a central database and cloud storage that forwards information and adjusts every price tag in the store and synchronizes prices in all physical and online stores. Those digital price tags are connected with the cash register and POS systems through radiofrequency (Solomon & Deeter-Schmelz, 1993).

The ESL is a digital retail innovation where price and other relevant product information are placed on a liquid crystal display [LCD] or electronic paper technology [e-paper] (Boden et al., 2020). The need to refresh the LCD display multiple times per second even if there are no changes applied and the high energy consumption is unpromising for businesses (Sung, 2015). It is assumed that e-paper will most likely be the largest used low-power substitute due to its simple design, readability, and different functions of the display like full graphics which are more appealing due to the wide range of colors (Bombe, 2021). Another benefit of e-ink over the LCD is that content is like a paper poster and can be readable in direct sunlight which allows for more interactive solutions provided by electronic paper technology. Digital signage is not limited to in-store shelf labels but has applications such as interactive signs, airport signage, posters, notice boards, etc (Primožic, 2015).

Another synonym for e-paper is electrophoretic display or EPD. Its name is derived from its function since it operates by creating a reaction between clear fluid and ink particles in capsules when electricity is applied. What makes this sound advantageous is that power consumption happens only during the content change (e.g. flipping the book page on an e-reader) so in case of a power outage the content displayed will hold the same image, making this screen type energy-efficient (Primožic, 2015).

Other than well-known communication technologies like Wi-Fi and Bluetooth, Radio Frequency Identification [RFID] and Near Field Communication [NFC] are used for product price updates (Bombe, 2021). The key difference is in the scope of transmission since the NFC is a low-battery coil that allows for short-distance data transfer by using radio waves (e.g. speakers, smartwatches), and RFID is used for longer range and most commonly in a form of FASTag toll payments (ENC in Croatian tolls). RFID technology enables bidirectional communication from a longer distance which gives it an advantage over bar and QR codes that are “limited by the need for line-of-sight” (Fernández-Caramés & Fraga-Lamas, 2018, p.5). Although traditional labels with bar and QR codes are attractive to businesses because of the low cost, this inexpensiveness brings a burden of manual updates and limits employees and sensors to make remote adjustments (Fernández-Caramés & Fraga-Lamas, 2018). Short-range wireless transmissions are also of big importance for customers since there is a growing amount of sensitive data which needs safe transactions. For example, most smartphones include NFC hardware. This is what allows for contactless mobile payments when the pop-up notification requests authentication (Wankhede, 2021). These technologies enable the Internet of Things which turns mundane objects into smart objects by connecting them to the internet and allowing for „two-way communication“ (Sung, 2015, p.216).

Benefits of implementing ESL

What makes this price display more convenient than traditional paper labels is the fact that up-to-date prices (e.g. discount price) and related product information such as review ratings are managed across channels and provide transparency for customers due to correct price and the in-depth product information displayed (Boden et al., 2020; Bombe, 2021). This concept provides the same level of functionality for brick-and-mortar stores as for online stores (Boden et al., 2020). It allows physical stores to have features of the online stores where

consumers are provided with the product ratings, features, and suggestions similar to the product displayed. The exposure of user-generated content provides transparency which could ultimately influence the purchase intention of customers. In the same way as when buying a pair of jeans and the website recommends other similar products customers might be interested in, retailers can similarly influence consumers' choice and highlight the price advantages so that customers get an insight into great deals and therefore lower their intention to look for lower prices elsewhere. According to Roy (2004), these tags could also prevent shoplifting which costs businesses billions of dollars a year.

The adoption of ESL could contribute to the increase in the bottom line profits by enabling better dynamic pricing possibilities for the firms competing for customers as well as the operational cost savings because there is no need for employees to change prices on the shelves (Bombe, 2021). Consequently, it eliminates the potential errors that occur from manual work. Instead, the prices are easy to update because the tags are centrally controlled meaning that the price is updated automatically from the central server across all stores. The biggest goal of this technology is to allow for quick scanning and identification of items equipped with RFID tags in grocery carts and to accurately distinguish them and as a result, accelerate the process. This would result in great savings and return on investment as the RFID systems can help manufacturers and retailers with inventory tracking. In near future, this technology will likely be implemented in home appliances (e.g. coffee machine switching on automatically as a person leaves the bed) making it easier for people to focus on more important work-related activities (Roy, 2004).

It's not only time and labor inefficiency regarding price changes of thousands of paper labels that is a problem (Bu, Tsutomu & Hidetaka, 2015). This results in a delay of price updates between the price that is put on the shelf and the point of sale machine where the

transaction is completed. Hence, it can lead to customers' frustration because of the price mismatch and increased employee stress. As a solution, electronic labels are interconnected with the POS database so the price updates are synchronized which results in more accuracy and efficiency in dynamic pricing management. These labels are not limited to the retail sector and specialists are constantly looking for new ways to make these displays durable and to be able to operate outdoors under all weather conditions („Find Your Outdoor Fun,“ 2021). This would for example benefit the hospitality and tourism sector and positively affect travelers as e-paper technology would provide them with tourist information that is timely and accurate.

Concerns regarding the electronic labels market

As with any technological innovation, the biggest challenges are customer attitudes related to privacy and personal data security (Roy, 2004). It is perceived as a tool used by marketers to spy on customers and use collected purchasing data to track individual preferences. The collected data enables them to make an accurate sales pitch. A lot of controversies related to these systems made big companies like Gillette argue that tags are not embedded in products which means that once consumers dispose of the packaging, there is no possibility of surveillance. In response to this concern, many retailers have started to implement so-called “tags with kill switches” which disable tags after the purchase at the checkout station (Roy, 2004, p.6)

Another setback could be the high costs related to the installment of this technology, especially as the hardware costs are nearly 90-95% of the overall ESL system cost Bombe (2021). Although the use of ESL would reduce paper waste, there is a concern that the number of battery disposal will likely cause environmental pollution (Bu et al., 2015). To solve the additional burden of requiring a large number of people to reinstall batteries in thousands of devices, the “wireless power transmission method” could be used for the power supply (Bu et

al., 2015, p.1). This type of wireless transmission provides electric power to the low-consumption ESL device. The way this method works is by placing a circle-shaped transmitting yoke in a way that it forms an enclosed magnetic loop in the device. As a result, batteries are not required for it to work.

The recent pandemic outbreak also imposes some challenges on this market (Bombe, 2021). Since the recent COVID-19 pandemic and the challenging measures it imposed, most people have turned to online shopping where they can easily make price comparisons of different businesses. They have turned from walking through the store allies to online shopping and looking for less expensive goods and services because the pandemic has resulted in a loss of jobs which placed the need for people to take their income into greater consideration. This could represent a setback for the growth of the electronic shelf labels market.

Challenges for the employees

Most of the research done on this topic has taken into consideration the benefits that this technology has on the business and customers (Barasljevska, 2019). Barely any research has touched upon the downsides and overall employee perspective regarding this innovation. Personnel usage of technology was limited to downloading, printing, and adjusting paper labels on the shelves manually (Barasljevska, 2019). In the case of electronic labels system, this would mean that employees would need to acquire the proper training to learn to operate software and maintenance tasks. Businesses might face resistance and lack of employee motivation to learn as they are ignorant of the benefits. Many employees might find this challenging because of the need to use a Personal Digital Assistant [PDA to speed up the process of connecting products with labels and maintaining the updates. The paradoxical nature promises benefits for businesses in terms of lower labor costs because sensors are used to track inventory and to alert servers in case of need for more inventory supply. Regardless, this calls

for the “displacement of workers” due to the lower need for manual work (Roy, 2004, p.7). However, David (2015) argues that although the general concern is that automation could put a ceiling on the economy by eliminating new jobs, automation actually complements the workforce. An example of an application that is complementing technology and employment can also be seen through automated teller machines [ATMs] introduced in the banking industry. Surprisingly, the ATMs increased the number of bank tellers as the focus was on establishing relationships with customers and providing them with additional information on other bank services such as investment possibilities, etc. Similarly, ESL complements employees as they can assign more time and effort to help customers and understand their preferences („3 Ways Electronic Shelf Labels,“ 2022). The importance of employee engagement has been supported by data that over 50% of customers said that they „would switch to a competitor after a single bad experience“ („3 Ways Electronic Shelf Labels,“ 2022).

It could be valid that the automation of the retail industry allows employees to focus more on customer service whose satisfaction would ultimately improve the sales, brand image, and bottom line profits (Barasljevska, 2019). Still, the failure of implementation can backfire on the business, therefore to assess the employees’ perceptions of the adoption and usefulness of new technology, businesses can use the Technology Acceptance Model [TAM]. It allows managers to evaluate the employees’ attitudes on the usefulness in the workplace (perceived benefits and enhancing performance) and ease of use (convenience) regarding the new and potentially improved ways of doing business (Allen, 2020). The results can call for action to take to “decrease employee resistance and under-utilization of a novel technology” (Barasljevska, 2019, p.13).

Investment cost

The cost of RFID systems depends on the level of automation that store managers want to get and there are three tag types ranging from \$0.10 per piece to \$20, depending on the level of functionality and automation (Roy, 2004). Additional costs of infrastructure to operate passive RFID systems such as RFID readers and antennas might discourage businesses to choose passive RFID systems regardless of their inexpensive tags (\$0.10 - \$1.50 per piece) (Wolk, 2020). Whilst ten cents might not sound like a lot at first, it doesn't make economic sense when considering applying it to low-cost products like \$1 candy, especially since the price of needed RFID readers can range from \$1,250 to \$20,000 per piece (Roy, 2004; „The Shocking Price,“ 2016). Active RFID systems are more expensive in terms of tag price (\$10+) but the cost of infrastructure is around 10 times lower than for passive systems (Wolk, 2020). Passive systems require an expert and running connectivity tests is both complex and time-consuming. On the other hand, active systems take just one day to set up and usually come in a bundle with software. The biggest limitation of passive RFID systems for stores would be that there is no option for inventory tracking. Not having an inventory tracking option represents a significant pain point for businesses because they would not be able to visualize if there is a shortage or surplus of inventory (Valentin, 2022).

Methods

Instrument

The present study investigated the attitudes of employees on Electronic Shelf Labels. To research the attitudes of retail employees toward the system of ESL and the implementation of such technology in the workplace, the study utilizes a shortened version of the web survey “United theory of acceptance and use of technology model” [UTAUT] obtained from the Blekinge Institute of Technology (BTH) (Barasljevska, 2019, p.6).

The original survey was distributed to retail employees in a Swedish organization who are already familiar with using the ESL system. Therefore, for this research, the questions were modified to future tense to be more suitable for employees who are not introduced to this technology.

The survey is divided into seven sections consisting of twenty-three close-ended questions which are a combination of the five-point Likert Scale and multiple-choice questions. In the first set of questions, participants were asked to answer two multiple-choice questions regarding the store type and store size. In the original survey, the question regarding the size of the store offered options of “large, medium, and small” with no clear definition (Barasljevska, 2019, p.63). The question was adjusted and squared meter measurements were added for better clarification. In the second section, the participants were asked to answer six Likert-scale questions regarding the performance expectancy, or in other words, the perceived usefulness of implementing ESL systems in the workplace. An additional question was added in this section regarding the possibility of the ESL system leading to displacing workers due to automation was added due to its relevance to the literature review. The third and fourth sections of the survey were focused on the perceived ease of learning to use ESL systems as well as the knowledge needed to operate

such. The attitude towards usage was the final section of this survey, followed by questions regarding the employee work experience and demographic questions.

The original survey was written in the English language. Since the requirement was for participants to work in Croatian stores, the survey was translated into Croatian for convenience and better comprehension. The results were analyzed through the IBM SPSS Statistics Software for descriptive statistics.

Participants

The survey was distributed to past or present store employees who worked or still work in any job position within any type of retail store in Dubrovnik area. To reach a larger number of respondents, the survey was administered both electronically (accessible through a barcode and e-mail) and on paper. Ultimately, the sample size was sixty-six participants, with fifty-five responses online and eleven collected on paper by distributing the survey to employees within selected retail stores. For confidentiality and anonymity purposes, none of the employee names or information about the companies in which they were/are employed were recorded. Informed consent was obtained from every participant before filling out the survey. Participants were asked to distribute given surveys to other employees appropriate for this research purpose. The largest number of respondents were female (n=50). Other sociodemographic characteristics of the participants are provided in Table 1.

Table 1. Respondent's socio-demographic and professional characteristics

	<i>N</i>	<i>%</i>
GENDER		
Male	13	19,7
Female	50	75,8
Prefer not to say	3	4,5
AGE		
Under 18	1	1,5
18 - 25	36	54,5
26 – 35	8	12,1
36 – 45	14	21,2
46 – 55	3	4,5
Over 55	4	6,1
COMPLETED EDUCATION LEVEL		
Elementary School	1	1,5
High School	20	30,3
College	9	13,6
University and higher degree	36	54,5
Working experience at the store (in years)		
Less than 1 year	23	34,8
1 – 3 years	25	37,9
More than 3 years	18	27,3
Current job position at the store		
Salesperson	39	59,1
Cashier	6	9,1
Store manager	11	16,7
Deputy store manager	4	6,1
Assistant store manager	4	6,1
Other	2	3,0

The majority of respondents were employees in a clothing store (n=19), followed by grocery stores (n=11) and cosmetics stores (n=11). Other categories differ insignificantly from one another. Based on the store size, the largest number of respondents were employed in a medium store (n=41), followed by a small store (n=15).

The rest of the data on the type and size of the store is available in Table 2.

Table 2. Number of respondents based on type and size of the store

Store Type	N	%
Groceries	11	16,7
Clothing	19	28,8
Footwear	3	4,5
Sports equipment	5	7,6
Furniture	3	4,5
Home appliances	1	1,5
Toys	2	3,0
Electronic devices	7	10,6
Cosmetics	11	16,7
Gas Station	2	3,0
Other	2	3,0

Store Size	N	%
Large store (at least 2500m²)	8	12,1
Medium store (400m² – 2500m²)	41	62,1
Small store (12m² – 400m²)	15	22,7
Discount store (at least 50m²)	2	3,0

Results

The purpose of this research was to examine the attitudes of retail employees toward the system of Electronic Shelf Labels and the implementation of such technology in the workplace. Participants' ratings of the perceived influence of ESL on their job performance were highest for item 'I would find ESL useful in performing my job tasks (e.g. managing inventory),' ($M=4.62$, $SD=.674$), closely followed by 'I would think that ESL would enable me to perform tasks more quickly' ($M=4.55$, $SD=.727$). However, participants were overall positive regarding performance expectancy and there was no significant difference between ratings among questions (for additional data see Table 4 below).

Table 4. Perceived influence of ESL on employee job performance

Performance Expectancy	<i>M</i>	<i>SD</i>	N
I would find ESL useful in performing my job tasks (e.g managing inventory):	4,62	,674	66
I would think that ESL would enable me to perform tasks more quickly:	4,55	,727	66
I think that ESL would make it easier for me to focus on other job tasks (e.g. customer service):	4,42	,725	66
I think that ESL would increase the quality of performing my job tasks:	4,36	,835	66

In the third section, the highest score responses were for item ‘ESL would be easy to use,’ ($M=4.38$, $SD=.674$) and the lowest for ‘Using ESL would not be frustrating,’ ($M=4.03$, $SD=.928$). See Table 5.

Table 5. Perceived ease of use of ESL

Effort Expectancy	<i>M</i>	<i>SD</i>	N
ESL would be easy to use	4,38	,674	66
Learning how to operate ESL would be easy for me:	4,06	,892	66
Using ESL would not take too much time for performing other job tasks:	4,27	,869	66
Using ESL would not be frustrating:	4,03	,928	66

In the fourth section regarding the facilitating conditions, the item ‘I feel that I have the knowledge needed to use ESL’ recorded the highest deviation in responses, ($M=3.77$, $SD=1.187$).

Table 6. Facilitating conditions

Facilitating Conditions					
	N	Minimum	Maximum	<i>M</i>	<i>SD</i>
I feel that I have the knowledge needed to use ESL:	66	1	5	3,77	1,187
I feel that ESL would be compatible with other systems:	66	2	5	4,18	,893
I feel that there would be needed support available when ESL-related difficulties arise:	66	3	5	4,61	,677
Education in learning ESL would be available for me:	66	2	5	4,35	,868
Valid N (listwise)	66				

There was no effect detected for demographic variables for any of the items in the survey. Overall, participants felt positive about the possibility of using ESL as a new system in their workplace ($M=4.47$, $SD=.827$), followed by ‘I feel that the use of ESL would be beneficial for my job performance,’ ($M=4.15$, $SD=.932$).

Table 7. Employees’ attitude towards usage of ESL

Attitude towards usage					
	N	Minimum	Maximum	<i>M</i>	<i>SD</i>
I feel positive towards the possibility of using ESL as a new system.	66	2	5	4,47	,827
I feel that the use of ESL would be beneficial for my job performance.	66	2	5	4,15	,932
Valid N (listwise)	66				

Discussion

The main objective of this research was to explore the attitudes and perceptions of retail employees toward the system of electronic shelf labels and the implementation of such technology in the workplace. Given the sample size and focus on the specific area, the results can serve as a base for further research on the topic of ESL not only for the retail industry but also implications in various other industries as well as the interaction of this particular technology with employees.

The analysis of results regarding employees' perceived influence of ESL on their job performance revealed a high level of usefulness provided by this system. The findings of this study suggest that participants were overall positive and there was no significant difference between results in the two groups compared. The rating for the item 'I would find ESL useful in performing my job tasks (e.g. managing inventory),' was slightly higher for small stores ($M=4.73$, $SD=.458$) than for medium stores ($M=4.56$, $SD=.776$). According to the literature review, delay of the price updates due to the manual price changes of thousands of paper labels could lead to customers' frustration because of the price mismatch which could ultimately increase employee stress (Bu, Tsutomu & Hidetaka, 2015). One of the assumptions was that employees who work in larger stores could see a bigger benefit from these systems due to the greater number of inventory supplied and workload. However, findings show that there is no significant correlation between store size and the expected performance of particular job duties.

A surprising number of participants agreed that they are familiar with the ESL concept (54,6%). In addition, an interesting finding is that majority of respondents feel positive about the possibility of using ESL as a new system ($M=4.47$, $SD=.827$). What this suggests is that, although the other half is not familiar with the concept there is still a positive attitude and focus on the benefits and assistance that these systems could provide once they are implemented.

These results can serve businesses as a problem-solving opportunity as participants were overall positive and stated a need for assistance in job performance.

Limitations

When discussing the limitations of this research, it was done in fourteen weeks. The sample size of sixty-six participants was quite small to form a strong conclusion. This implies that further research on the topic should focus on a larger sample size and broader focus in terms of the geographical locations of companies.

Many companies that were reached out declined to help with the distribution of questionnaires among their employees. Therefore, it would be interesting to conduct future research on this topic by organizing an interview or discussing the ESL systems through focus groups of employees and managers of one particular company. This way, it would be easier because there would be an opportunity to educate the company and employees on this technology before the discussion.

Originality

The original survey obtained from the Blekinge Institute of Technology (BTH), (Barasljevska, 2019) was focused on exploring the attitudes of retail employees in a Swedish organization who are already familiar with the ESL and using such technologies in their organization. On the contrary, this study investigates the attitudes towards the above-mentioned systems in organizations that are not implementing such systems yet, but there could be a potential for future application in their workplace.

Practical implications

This study shows the overall positive attitudes of employees towards new technologies that could assist them in daily operations. The positive inclination could be of use to business managers who seek to enhance the quality of job performance for their employees. An additional knowledge obtained from this topic could improve employees' job satisfaction, customer satisfaction, and bottom line profits.

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