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Research Paper

Redesigning Work: A Student-Learning Initiative for Safer and Smarter Ergonomic Carts

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Abstract

Ergonomic carts improve safety, reduce strain, and enhance efficiency, but their real-world impact remains unseen. This service-learning initiative, driven by students, aims to assess the impact of ergonomic carts on comfort, usability, and musculoskeletal disorders, providing insights to refine user-centered designs and improve operational outcomes. An exploratory sequential mixed-methods approach using purposive sampling was employed to gather data from 14 qualified beneficiaries. The study evaluated key aspects such as productivity, carts' durability, and ergonomic benefits, and how these features influence the overall user experience. Data were analyzed using weighted mean and standard deviation while maintaining ethical standards. Most respondents were women, aged 41-60, highlighting the cart's relevance for age-related impairments. Daily use indicated ergonomic benefits, improved productivity, time management, and comfort, with high durability and adaptability scores. The cart reduced musculoskeletal pain, improved posture, and decreased fatigue. Participants also noted cost savings, reduced waste, and improved community organization. The study's scope was limited to specific demographic groups, suggesting the need for broader future research. This study highlights the importance of ergonomic interventions in workplace tools and advocates for user-centered designs that enhance well-being and productivity. To address Sustainable Development Goals 1, 3, 8, and 12, this study promotes inclusive economic growth, healthier work environments, and sustainable practices.

Keywords: *Ergonomics, Musculoskeletal Disorder, productivity, user satisfaction, workplace efficiency*

INTRODUCTION

"No one is useless in this world who lightens the burdens of another." Charles Dickens. Since many of us are committed to supporting our communities, including local vendors, implementing ergonomic innovations can have a significant impact on its users. Ergonomics goes beyond design, it is beneficial to its users. In addition, it embodies a strategic approach that combines human-centered standards with systematic control. This involves a collaborative effort between individuals and structural components, data, procedures, benchmarks, and theories to develop designs for safer and smarter performance (Aravindah et al., 2020). Nowadays, manual labor is customary, and innovations in ergonomics play a vital role in the efficient, safe, and reduction of physical strain. Ergonomically designed carts, as one of these innovations, are usually recognized for their ability to reduce musculoskeletal disorders (MSDs) and improve user experience. Hasanain (2024) emphasized the importance of recognizing human capabilities, attitudes, and limitations when designing machines, workplaces, and environments to ensure meaningful and safe human use. Similarly, Lucas et al (2024)

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highlighted that managing excessive workloads through ergonomic improvements helps reduce absenteeism, ensure a stable income, enhance productivity, and expand financial opportunities, ultimately leading to better living conditions.

However, despite the known benefits of ergonomic carts, existing studies have primarily focused on design and controlled laboratory evaluations, leaving a significant gap in assessing their real-world effectiveness and user satisfaction, particularly for informal workers such as street vendors. Fausto et al. (2018) identified key ergonomic shortcomings in cart design, such as weight distribution, handle design, and canister depth, that contribute to high Rapid Entire Body Assessment (REBA) scores, increasing the risk of MSDs. While these studies highlight design flaws, they do not evaluate how ergonomic modifications impact users' day-to-day experiences, productivity, or long-term health outcomes. Additionally, prior research lacks engagement with vendors themselves, missing valuable user feedback necessary for refining practical, user-centered assistance. To address this gap, a student-led service-learning initiative explores the impact of ergonomic cart designs on comfort, usability, and MSD reduction. This initiative highlights how engineering interventions can cultivate sustainable livelihoods. By easing the physical burden on vendors, ergonomic improvements ensure that they can work longer and more effectively, reducing injury risks and increasing their daily earnings. Ergonomically designed carts play a vital role in improving safety, reducing physical strain, and enhancing efficiency across industries. However, despite the recognized benefits of these carts, there has been limited evaluation of their real-world effectiveness and user satisfaction, particularly for street vendors. Fausto et al (2018) proved in their study that several aspects of the cart, such as weight, handle design, canister depth, and handle distance, need modification to reduce vendors' REBA (Rapid Entire Body Assessment) scores and minimize their discomfort. The proposed method evaluates posture during various tasks to identify risks for MSDs and highlights the need for ergonomic improvements.

A key focus of this initiative is supporting street vendors in *Barangays Sauyo, Bagbag, San Bartolome, and Nagkaisang Nayon* in Quezon City, Philippines. These vendors, reliant on manually operated carts for their livelihoods, often experience severe physical strain due to prolonged hours of pushing and pulling heavy loads under challenging conditions. The absence of ergonomic considerations in carts exacerbates the risk of developing MSDs, affecting both their health and their earning capacity. Addressing this issue is critical because well-designed ergonomic carts can improve working conditions, reduce discomfort, and enhance productivity, ultimately strengthening their economic sustainability. A milestone in this research was the launch of ErgoCon on December 1, 2023, an event that showcased the progress of student-led ergonomic cart innovations. Beyond being a platform for collaboration, ErgoCon served as a key motivation to conduct this study, gathering initial user feedback from users who tested the prototype designs. These insights provided essential usability data and areas for improvement, guiding this study in identifying key challenges and how to support the needs of its users.

In addition, this study aligns with several United Nations Sustainable Development Goals (SDGs) by addressing key socioeconomic and health challenges. SDG 1: No Poverty is supported by empowering street vendors to improve their livelihoods through enhanced productivity and reduced physical strain. SDG 3: Good Health and Well-being is advanced by promoting safer working conditions and mitigating MSD risks. Furthermore, SDG 8: “Decent Work and Economic Growth” and SDG 12: “Responsible Consumption and Production” are reflected in the promotion of sustainable work environments and efficiency in manual labor.

This study aims to assess the real-life impact of ergonomically designed carts on street vendors, specifically in terms of their comfort, usability, and the reduction of musculoskeletal disorder (MSD) risks. It seeks to determine how these carts influence vendors’ work efficiency, health, and overall well-being.

To achieve this, the study addresses the following research objectives:

1. Identify the demographic profile of the respondents.
2. Assess the respondents' evaluation of the ergonomically designed cart in terms of its capabilities and durability.
3. Measure the perceived effects of the ergonomically designed cart on well-being, community organization, and financial stability.
4. Evaluate respondents' overall satisfaction with the use of the ergonomically designed cart.

This study fills an important gap by conducting a comprehensive impact assessment of ergonomically designed carts. Through the vendors' feedback and real-life evaluations, we examine their effectiveness in enhancing comfort, usability, and MSD risk reduction. The findings will specify helpful insights for improving ergonomic design by adopting innovative, user-centered solutions that create valuable improvements in diverse work scenarios.

LITERATURE REVIEW

In the Philippines, street vending is an important economic driver that promotes poverty reduction and creates employment opportunities. The country plays a vital role in the informal economy, providing livelihood opportunities for millions worldwide. However, the physically demanding nature of this occupation often exposes vendors to significant health risks, including musculoskeletal disorders (MSDs), because they regularly engage in prolonged walking, standing, and handling heavy loads. Ergonomically designed tools, such as carts, offer potential solutions to mitigate these risks while enhancing productivity and overall well-being.

Ergonomically Designed Tools

Ergonomically designed tools have emerged as critical innovations across various industries, offering solutions to reduce physical strain, enhance safety, and improve productivity. These tools are developed based on ergonomic principles and focus on aligning the design with users' physical and cognitive needs, ultimately minimizing the risk of musculoskeletal disorders (MSDs) and other work-related injuries. As mentioned by Panjaitan (2024), Ergonomics is the study of human factors in the workplace, integrating engineering, management, psychology, anatomy, physiology, and design to optimize efficiency, health, safety, and comfort in various environments, with work posture being a key factor in job effectiveness.

A significant area of research highlights the role of ergonomic tools in reducing physical strain and improving worker well-being. Santos et al. (2020) demonstrated that ergonomic tools tailored to individual user needs significantly decreased back pain and fatigue among manual laborers. By incorporating features such as adjustable handles and optimal weight distribution, these tools ensure comfort and ease of use during prolonged tasks. Similarly, Hignett et al. (2020) reported that tools designed with user-centric ergonomic principles reduced the incidence of repetitive strain injuries in high-risk professions, such as construction and manufacturing.

Productivity improvements linked to ergonomic tools have also been widely documented. A study by Hedge et al. (2019) revealed that ergonomic enhancements in tools like material handling carts lead to a 30% increase in task efficiency by reducing physical exertion and optimizing movement patterns. In healthcare, ergonomically designed instruments enable medical professionals to perform tasks more effectively while minimizing fatigue, as noted by Chen et al. (2021). These findings suggest that integrating ergonomics into tool design not only protects workers' health but also improves workflow efficiency.

Furthermore, ergonomically designed tools play a vital role in promoting inclusivity and

accessibility. Research by Lopez et al. (2022) highlighted how these tools enable older adults and individuals with physical limitations to participate more effectively in the workforce. Features like adjustable components and lightweight materials cater to diverse user needs, ensuring usability across various demographics. This inclusivity underscores the importance of ergonomic innovations in addressing the challenges of the aging workforce.

Despite these advantages, challenges remain in assessing the long-term effectiveness of ergonomic tools. Wilson and Corlett (2019) stressed the need for longitudinal studies to evaluate how these tools perform under real-world conditions over time. They argued that user feedback and iterative design improvements are essential to ensure that ergonomic tools meet evolving workplace demands. Similarly, Garcia et al. (2021) called for interdisciplinary research to explore the intersection of ergonomic design with emerging technologies, such as smart sensors and automation, to further enhance usability and effectiveness.

Musculoskeletal Health

Ergonomic interventions have consistently been shown to improve musculoskeletal health by reducing strain and discomfort among workers. Ergonomically designed carts are recognized as critical tools for minimizing the risk of musculoskeletal disorders (MSDs), which are prevalent among individuals in physically demanding occupations such as street vending. Recent studies have emphasized the importance of ergonomic design features, such as adjustable handles, smooth mobility, and balanced weight distribution, in reducing physical strain. For instance, Chen et al. (2018) reported that ergonomic tools significantly reduce back and joint pain by improving posture and distributing physical loads more effectively. Similarly, Hignett et al. (2020) found that user-centered ergonomic designs decrease the prevalence of MSDs among workers by addressing their unique physical demands. Moreover, Ramirez (2023) emphasized that health risks as perceived by workers, including musculoskeletal discomfort, speak to the significance of ergonomics in various work settings. The findings further highlight the importance of ergonomic intervention to ensure health and well-being at work, whether during strenuous activities or during sedentary periods.

Ruliati et al. (2015) also showed that ergonomic improvements in work conditions can reduce fatigue and musculoskeletal disorders encountered by workers. One thing their study emphasized is that particular ergonomic interventions, tailored to the unique demands of a job, can lead to significant health benefits by minimizing physical stress and enhancing overall work efficiency.

Productivity and Workflow Efficiency

Beyond health benefits, ergonomically designed carts have a direct impact on productivity and workflow efficiency. Research by Konz and Johnson (2020) in the manufacturing sector and revealed that the integration of ergonomic tools reduces task completion times and enhances the efficiency of material handling processes. In a similar vein, studies on informal economic settings, such as street vending, have suggested that these carts streamline operations, enabling users to serve more customers while expending less physical effort (Hedge et al., 2019). A study by Santos et al. (2021) further demonstrated that ergonomic designs tailored to users' needs increase job satisfaction and reduce absenteeism caused by work-related physical ailments. Chayani (2024) also added that improper manual material handling can lead to losses, accidents, and musculoskeletal complaints, especially when dealing with production areas. Thus, ergonomic principles must be considered.

Additionally, Shikdar et al. (2008) stated that ergonomic interventions greatly decrease health complaints among workers, which increases productivity and employee well-being. These findings highlight the multifaceted value of ergonomic design, contributing not only to physical

health but also to operational efficiency and performance in different work settings.

User-Centered Design and Real-World Application

The concept of user-centered design is foundational in the development of ergonomic equipment. As noted by Salvendy and Karwowski (2021), involving end-users in the design process ensures that tools are not only functional but also adaptable to diverse requirements. Features such as height-adjustable handles and durable materials enhance the usability and satisfaction of devices in various demographics. Wilson and Corlett (2019) stressed the importance of evaluating ergonomic tools in real-world settings to identify areas for improvement and refine design specifications. This is particularly important in sectors like street vending, where the operational environment poses unique challenges, such as uneven terrain and extended working hours (Lopez et al., 2022).

The socioeconomic and community impacts

Ergonomic interventions extend beyond individual benefits to positively affect communities and socioeconomic conditions. Santos et al. (2021) noted that ergonomic carts for street vendors enhance financial outcomes by improving vendor efficiency and reducing operational costs. Additionally, ergonomic tools contribute to better community organization by enabling vendors to manage their spaces more effectively and maintain cleaner environments. According to Garcia et al. (2021), interventions such as ergonomic carts can also foster social inclusion, particularly among women and older adults, by reducing the physical barriers that limit their participation in labor markets.

Ergonomics for Sustainable Development

This alignment with Sustainable Development Goals (SDGs) highlights the transformative impact of ergonomics across multiple sectors. The following SDGs make essential contributions to creating a more sustainable and equitable future regarding SDG 1-No Poverty. Smith & Tailor (2020) demonstrated that ergonomic practices can significantly enhance productivity in low-income settings, thereby directly contributing to economic resilience. These practices also play a key role in alleviating poverty in developing economies by reducing the number of injury-related work absences (Khan & Patel, 2021). In informal sectors, ergonomic interventions foster economic stability by improving efficiency (Osei & Dlamini, 2019). Additionally, ensuring ergonomic safety helps maintain income stability among manual laborers, minimizing the risk of job loss due to health-related issues (Rahman & Yusuf, 2022).

For SDG 3- "Good health and well-being," Chen et al (2018) mentioned that ergonomic cart designs help reduce musculoskeletal disorders, thereby enhancing employee well-being. Moreover, ergonomic tools significantly improve mental well-being, especially in high-stress occupations, and musculoskeletal challenges in the workplace are work-related injuries (Irwanti, 2024). Comprehensive reviews of ergonomic interventions have highlighted their role in promoting both physical health and mental wellness (Morales & Singh, 2021). In health care settings, ergonomic assessments are critical for reducing physical strain and improving overall health outcomes (Tanaka & Suzuki, 2023).

Regarding SDG 8 (Decent Work and Economic Growth, ergonomic interventions contribute to creating productive and safe work environments. These practices not only enhance safety but also improve economic performance in manufacturing industries (Gonzalez & Martinez, 2020). The economic benefits of workplace ergonomics extend beyond productivity gains, promoting long-term growth by reducing healthcare costs (Ahmed & Zhang, 2019). Moreover, ergonomic interventions boost job satisfaction, particularly in small and medium enterprises (Johnson & Lee,

2022). By fostering decent work environments, ergonomic practices help reduce occupational hazards, thereby supporting sustainable economic growth (Torres & Kim, 2021).

Regarding SDG 12—Responsible Consumption and Production, sustainable design practices that incorporate ergonomic principles help reduce waste in production systems (Park & Choi, 2019). Ergonomically designed products foster responsible consumption by extending product life cycles (Green & Foster, 2021). Additionally, ergonomic innovations in industrial practices enhance sustainability by optimizing resource use (Wang & Li, 2022). Workplace optimization through ergonomics also reduces unnecessary resource consumption and promotes environmentally friendly practices (Silva & Costa, 2023).

The ergonomic cart contributes to long-term sustainability by improving health, work efficiency, and environmental impact, aligning with multiple Sustainable Development Goals (SDGs). It supports SDG 3 (Good Health and Well-Being) by reducing musculoskeletal disorders and fatigue, allowing vendors to work longer with less physical strain. It also promotes SDG 8 (Decent Work and Economic Growth) by enhancing productivity, enabling vendors to serve more customers and sustain their businesses. Additionally, the cart aligns with SDG 12 (Responsible Consumption and Production) through its durable design, reducing waste and the need for frequent repairs or replacements. By improving working conditions and increasing income stability, it also indirectly supports SDG 1 (No Poverty), helping vendors maintain a sustainable livelihood. Overall, the ergonomic cart fosters long-term sustainability by enhancing worker well-being, economic resilience, and environmental responsibility.

RESEARCH METHOD

This study adopted an exploratory sequential mixed-methods approach to investigate the impact of an ergonomically designed cart on users and the community. As mentioned by Shiyanbola et al. (2021), an exploratory sequential approach integrates qualitative and quantitative findings. The responses were analyzed to identify the quantitative phase. Moreover, George (2025) stated that the mixed method is appropriate for expanding the findings of the study. Purposive sampling was used to select 14 qualified participants. They were selected as beneficiaries based on specific criteria that ensured relevance to research on ergonomic carts for street vendors. The criteria are as follows: active street vendors who relied on manually operated carts for their daily work, making them ideal candidates to assess the carts' impact on comfort, usability, and musculoskeletal strain.; to have at least one year of experience using traditional carts, ensuring they had sufficient familiarity to compare the ergonomic cart with their previous setup.; selling goods such as street food, fruits, vegetables, and beverages, as these occupations involve frequent movement and heavy lifting, making ergonomics a crucial factor in their work efficiency and well-being. While participants were not required to have pre-existing musculoskeletal conditions, the study targeted individuals who experienced physical strain from pushing and pulling carts, as they stood to benefit most from an ergonomic design that reduces fatigue and discomfort.

This study employed a descriptive research design. Data collection involved surveys and semi-structured questionnaires. For qualitative analysis, semi-structured interviews and direct observations were conducted to explore vendors' experiences, challenges, and feedback regarding their current carts. This phase helped identify key ergonomic issues and areas for improvement. Key themes were identified, including health and safety (e.g., reduced musculoskeletal strain, improved posture, and reduced fatigue), productivity (e.g., increased efficiency and improved workflow), user satisfaction (e.g., comfort and design feedback), and durability (e.g., long-lasting design and usability in harsh conditions). Responses were categorized by theme, and data were analyzed using weighted mean and standard deviation to identify patterns and interpret the findings. For quantitative analysis, insights from qualitative data were used to design a structured

instrument. This survey collected measurable data on key aspects such as productivity, health benefits, and financial impact, providing a more comprehensive evaluation of the ergonomic carts. To facilitate statistical analysis and interpretation, a four-point Likert scale was used (Joshi et al., 2015). The scale allows respondents to express their level of agreement, thus ensuring consistency in data measurement. The following rating system was applied: Strongly Agree (3.51–4.00), Agree (2.51–3.50), Disagree (1.51–2.50), and Strongly Disagree (1.00–1.50). The questionnaire was developed based on the literature review and the study objectives. Each item was carefully designed to align with the research variables and was reviewed for clarity and relevance. To ensure the instrument's validity, expert validation was conducted, followed by a pre-test with three vendors. Based on the result of Cronbach's alpha, the scale measuring the productivity and health impacts of the ErgoCart on current users had good reliability ($\alpha = 0.800$), the scale evaluating the health benefits of using the ergonomically designed cart ($\alpha = 0.876$), and the scale evaluating the impact of the ergonomically designed cart on community organization and financial status had acceptable reliability ($\alpha = 0.711$). These results imply that the study's scales were valid and appropriate for assessing the desired constructs. SPSS software was used to analyze the data.

Ethical standards were rigorously maintained throughout the study, ensuring that participants were fully informed about the study objectives, duration, and their right to withdraw at any time. Informed consent was obtained from all participants, ensuring transparency and respect for their rights

FINDINGS AND DISCUSSION

Demographic Profile of Respondents

Table 1. Frequency and Percentage Distribution of Respondents by Age

Profile	Indicator	Frequency (n=14)	Percentage
Age	30-40	1	7.14%
	41-50	4	28.57%
	51-60	4	28.57%
	61-70	3	21.43%
	71-80	2	14.29%
Gender	Male	12	85.71%
	Female	2	14.29%
Products Sold	Street Foods	5	35.71%
	Fish and Meat	1	7.14%
	Palamig	2	14.29%
	Fruits and Vegetables	2	14.29%
	Others	4	28.57%
Years of selling	1-10	7	50.00%
	11-20	4	28.57%
	21-30	1	7.14%
	41-50	1	7.14%
Number of Dependents	0	4	28.57%
	1-5	10	71.43%
Frequency of usage per week	Every day	8	57.14%

Profile	Indicator	Frequency (n=14)	Percentage
	Once a week,	2	14.29%
	Three times a week,	1	7.14%
	Four Times a week	1	7.14%
	Five Times a week	2	14.29%
Average No. Hours used per day	1-4 times a week	3	21.43%
	5-8 times a week	6	42.86%
	9-12 times a week	3	21.43%
	13-16 times a week	2	14.29%

Table 1 shows noticeable demographic patterns, with most users being middle-aged women aged 41 to 60 years old. This age distribution indicates that ergonomically designed carts may be especially advantageous for people with age-related strength and flexibility impairments. The significant gender disparity, with 86% identifying as male, highlights the need for ergonomic designs that address the specific needs of female users. Nandi (2024) stated that physically demanding occupations are traditionally male-dominated because of societal expectations and gender roles. In addition, Wang et al (2024) justified in his study that male vendors preferred heavier transport equipment and that they performed physically demanding tasks for more income. Because men and women face different health risks and ergonomic needs, gender imbalance may limit the generalizability of the findings. It is recommended that future studies include a more balanced gender representation to broaden the applicability of ergonomic solutions.

Product preference data among vendors exhibits a wide range. The bulk of the vendors have one to ten years of experience, showing a consistent set of long-term customers. Furthermore, most vendors support one to five dependents, underscoring the significance of their earnings from this work. This reliance on income from cart-based businesses emphasizes the importance of ergonomically designed carts for sustaining everyday operations and family livelihoods.

Usage trends show that more than half of the participants use ergonomic carts daily, often for physically demanding tasks such as material handling and transportation. The results demonstrate that ergonomic design plays an important role in reducing strain. Overall, the statistics highlight the relevance of ergonomically designed carts in improving user comfort, efficiency, and health, especially for people who have physically demanding jobs.

Level of assessment of the ergonomically designed cart in terms of capability and durability.

Table 2. Level of assessment of the ergonomically designed cart
In terms of capability and durability

Capabilities of the Ergonomically Designed Cart	Mean	Std. Dev.	Interpretation
1. Transferring my goods to different locations has become easier compared to using my old cart.	3.36	0.84	Strongly Agree
2. I have become more productive in my selling activities since I started using the ergonomically designed cart compared to my old cart.	3.29	0.73	Strongly Agree

Capabilities of the Ergonomically Designed Cart	Mean	Std. Dev.	Interpretation
3. The time I spend completing my selling tasks has decreased since I started using the ergonomically designed cart compared to my old cart.	3.43	0.65	Strongly Agree
4. The ergonomically designed cart can be used in any climate or weather.	3.50	0.65	Strongly Agree
5. The ergonomically designed cart meets all my needs in a cart for selling.	3.71	0.47	Strongly Agree
Overall Mean	**3.46**	**0.67**	**Strongly Agree**

Table 2 demonstrates that ergonomically designed carts greatly improve user experience, making it easier to transfer objects while also enhancing convenience and mobility. These findings demonstrate that carts help users be more efficient and effective. The respondents also commended the cart's durability and versatility, in the widespread agreement that it functions well in various weather conditions. Satisfaction with the cart's features was good, indicating that it fits all their vending requirements. The total composite means indicate that most people agree that the cart improves productivity, efficiency, and satisfaction. Well-designed carts increase morale and job satisfaction, validating the idea that ergonomic carts bring major benefits to users, ultimately improving performance and productivity. Mishra et al. (2024) also emphasized that ergonomic interventions can mitigate physical strain and enhance productivity across various occupational settings, highlighting the critical role of ergonomic design in improving workplace performance and well-being.

Table 3. Durability of the ergonomically designed cart

Durability of the ergonomically designed cart	Mean	Std. Dev.	Interpretation
1. The materials in the ergonomically designed cart are highly durable.	3.57	0.65	Strongly Agree
2. The ergonomically designed cart continues to look attractive.	3.64	0.50	Strongly Agree
3. The ergonomically designed cart makes it easy to move to different locations.	3.57	0.76	Strongly Agree
4. The ergonomically designed cart is capable of withstanding damage or impact.	3.64	0.74	Strongly Agree
5. The ergonomically designed cart remained in good condition even after long-term use.	3.79	0.43	Strongly Agree
6. The materials used in the ergonomically designed cart do not rust or decay.	3.64	0.63	Strongly Agree
Overall Mean	**3.64**	**0.62**	**Strongly Agree**

Table 3 shows that the ergonomically designed carts have a significant and favorable influence on beneficiaries, particularly in terms of durability, mobility, and visual attractiveness.

The respondents strongly agreed that the carts were made of sturdy materials that could endure repeated use and environmental challenges. The carts also maintain a visually appealing appearance over time, which is consistent with Johnson and Lee's (2019) results on the beneficial impacts of visually appealing equipment on workplace morale. Furthermore, the carts are very maneuverable and easy to reposition, implying that their design decreases the physical strain while increasing the maneuverability. In addition, Wurzelbacher et al. (2020) highlighted the effectiveness of ergonomic interventions in material handling operations and demonstrated that such designs can significantly improve worker comfort, reduce physical strain, and enhance operational efficiency.

Further research reveals that the carts are very resistant to damage and continue to work successfully over time, demonstrating resilience in difficult conditions, a finding shared by Gonzalez and Martinez (2021) in their study on industrial equipment design. The materials are also corrosion- and decay-resistant, ensuring the carts' durability and stability in various situations. The overall mean demonstrates a high consensus among respondents that the carts meet their durability requirements, resulting in increased productivity, efficiency, and satisfaction.

Level of assessment of the effects of an ergonomically designed cart in terms of well-being, financial status, and community organization

Table 4. Effects of ergonomically designed carts on user wellbeing

Effect of ergonomically designed carts on user wellbeing	Mean	Std. Dev.	Interpretation
1. The ergonomically designed cart helped improve my posture while selling compared to my old cart.	3.64	0.63	Strongly Agree
2. The ergonomically designed cart has helped reduce the pain in my body (musculoskeletal disorders) while I am selling.	3.50	0.65	Strongly Agree
3. The ergonomically designed cart helped reduce the fatigue I experienced while selling the cart.	3.57	0.65	Strongly Agree
4. I have experienced positive changes in my body since I started using the ergonomically designed cart in my selling activities.	3.57	0.65	Strongly Agree
Overall Mean	**3.57**	**0.64**	**Strongly Agree**

Note: 1.00 - .74 = Strongly disagree, 1.75–2.49 = disagree, 2.50–3.24 = agree, 3.25–4.00 = Strongly Agree

Table 4 implies that the ergonomically designed cart has a considerable positive influence on user health, notably in terms of postural improvement and physical strain reduction. Respondents significantly agreed that the new cart improved their posture while vending, indicating that its design promotes better body alignment. This is consistent with research by Kumar and Kumar (2018), who discovered that ergonomic equipment can significantly reduce musculoskeletal stress. Furthermore, the cart's design has significantly reduced physical pain,

particularly musculoskeletal pain, which is frequent in employees with repeated duties. Punnett and Wegman (2014) found that ergonomic modifications in workplace equipment minimize discomfort and the incidence of musculoskeletal disorders.

Furthermore, the cart has helped reduce fatigue, most likely due to its user-friendly features that reduce physical effort and encourage more efficient work methods. This is consistent with Wilson and Corlett's (2019) findings that ergonomic tools can greatly reduce physical fatigue. Respondents also reported general physical improvements, which Marras and Karwowski (2006) credit to ergonomic designs that reduce muscle tension and improve comfort. Thus, the findings indicate agreement on the cart's effectiveness in supporting health, comfort, and productivity, reinforcing the broader benefits of ergonomic design for maintaining physical well-being. This finding is also supported by the study by Panjaitan et al. (2024), which highlighted the significant impact of ergonomics on posture. If a worker's posture at work is not optimal, they may experience discomfort, muscle strain, and excessive fatigue throughout their work hours, ultimately leading to decreased productivity.

Respondents experienced significant musculoskeletal strain before using ergonomic carts, including back pain, shoulder strain, and wrist discomfort from heavy lifting and pushing. Poor cart design also led to postural issues, fatigue, and difficulty in completing long shifts. Productivity was reduced due to slow maneuvering, frequent breaks, and reduced efficiency.

After using ergonomic carts, respondents reported less pain and strain, improved posture, and greater comfort. Adjustable handles and better weight distribution enhanced alignment, while reduced exertion lowered fatigue, increased endurance, and quicker and better service.

The use of ergonomic designs directly supports SDG 3: Good Health and Well-Being, which seeks to eliminate health hazards and increase general well-being in the workplace (United Nations, 2015). The ergonomic cart lowers MSDs and reduces fatigue, resulting in a healthier working environment for users. According to research, musculoskeletal diseases are among the most common occupational health issues worldwide (Punnett & Wegman, 2014; Bernard et al., 2012), emphasizing the importance of ergonomic interventions.

Additionally, the findings align with SDG 8: "Decent Work and Economic Growth," which emphasizes the importance of safe and secure working conditions. A study conducted by Ibrahim and Gaafar (2024) suggested that ergonomic interventions and improvements in working conditions should be implemented to reduce work-related musculoskeletal complaints and increase productivity.

Table 5. Impact of Ergonomically Designed Cart on Community Organizations and Financial Status

Impact of Ergonomically Designed Cart on Community Organization and Financial Status	**Mean**	**Std. Dev.**	**Description**
1. The ergonomically designed cart helped me reduce my selling expenses	3.64	0.50	Strongly Agree
2. Using the ergonomically designed cart helped me use all my selling tools properly.	3.57	0.51	Strongly Agree
3. Using the ergonomically designed cart helped reduce waste in my selling activities.	3.64	0.50	Strongly Agree
4. The ergonomically designed cart has helped organize the community where I sell more organized	3.64	0.50	Strongly Agree
5. Overall, using the ergonomically designed cart has helped improve my financial situation.	3.57	0.65	Strongly Agree

Overall Mean	**3.61**	**3.61**	**Strongly Agree**

Table 5 shows a strong positive consensus among respondents who agreed that the cart greatly reduced their vending expenses. Respondents also reported that carts improved the efficiency of vending tools. The cart also helped reduce waste in vending activities, with a high mean score. In addition, respondents reported that carts improved organization within their vending communities, which supports Vink et al.'s (2008) findings that standardized, ergonomically designed carts not only increase individual efficiency but also promote a more organized and cohesive marketplace environment.

These benefits support several Sustainable Development Goals (SDGs). The cart aids in achieving SDG 1: "No Poverty" because it empowers street vendors so that they can enhance their livelihoods based on higher productivity and less physical strain. SDG 8: Decent Work and Economic Growth is, in turn, reinforced through creating a sustainable working environment and increasing the economic opportunities associated with operational efficiencies. Meanwhile, it is linked to SDG 12: Responsible Consumption and Production by reducing waste and advancing sustainable vending practices, thus contributing to doing business in an environmentally responsible way.

Overall, the ergonomically designed cart had a favorable impact on vendors' financial and operational efficiency, resulting in cost savings, effective tool use, waste reduction, and enhanced community organization. These findings are consistent with Dul and Weerdmeester's (2008) findings that ergonomic interventions, such as adjustable, easy-to-use carts, promote more organized and efficient handling of tools and materials, resulting in increased productivity. Such designs save time and increase suppliers' efficiency by ensuring easy access to tools and minimizing modification time. Moreover, technical solutions can quickly improve working conditions because of a better way of doing the tasks Kabiesz and Bartnicka (2020).

Overall satisfaction level with the use of an ergonomically designed cart

Table 6. Overall user satisfaction in using the ergonomically designed cart.

Overall user satisfaction in using the ergonomically designed cart	Mean	Std. Dev.	Interpretation
1. Overall, I am satisfied with the design of my ergonomically designed cart.	3.79	0.43	Strongly Agree
2. Overall, I am satisfied with the performance of my ergonomically designed cart.	3.79	0.43	Strongly Agree
3. The ergonomically designed cart was easier to use than my old cart.	3.50	0.52	Strongly Agree
4. The ergonomically designed cart is more comfortable using than my old cart.	3.64	0.50	Strongly Agree
5. My ergonomically designed cart is durable.	3.57	0.65	Strongly Agree
6. I am satisfied with using the ergonomically designed cart because it has helped increase my sales.	3.71	0.47	Strongly Agree

7. Because I am satisfied with the overall results and impact on my life, I would recommend using the ergonomically designed cart to my acquaintances.	3.64	0.63	Strongly Agree
Overall Mean	**3.66**	**0.52**	**Strongly Agree**

Note: 1.00 - .74 = Strongly disagree, 1.75–2.49 = disagree, 2.50–3.24 = agree, 3.25–4.00 = Strongly Agree

As shown in Table 6, beneficiaries are generally satisfied with the ergonomically designed carts. The respondents strongly agreed that the carts met their design and functional specifications, were easier to operate, and were more comfortable than the previous carts they had used. The durability of the carts also contributes to long-term user satisfaction. The respondents particularly noted that these carts positively influenced their livelihoods, as evidenced by their increased earnings. Their willingness to recommend these carts shows an additional way that the positive user experience has driven practical benefits. These findings substantiate SDG 1: "No Poverty," given that improved usability and comfort in carts allow vendors to work more efficiently and possibly earn more income, thus alleviating poverty status.

A general composite mean indicates a strong variation among respondents regarding their agreement regarding the effectiveness of carts and their positive impact on work and daily life; this supports findings by Emmatty and Panicker (2019), who emphasized that ergonomic interventions among workers significantly improve work efficiency, comfort, and overall well-being. Their systematic review highlighted that ergonomic designs can reduce physical strain, increase productivity, and enhance job satisfaction, aligning with the observed positive outcomes in the current study. Garbie's (2014) research, which demonstrates that incorporating ergonomics into work systems can considerably improve productivity, safety, and worker satisfaction. Besides, the results support SDG 8: "Decent Work and Economic Growth," as these improvements have provided suitable working conditions for small vendors and entrepreneurs, thus fostering the creation of decent working places and sustaining economic growth.

Assessment of the various parts of the ergonomically designed cart in terms of its durability, design, and quality

Table 7. Assessment of the various parts of the ergonomically designed cart in terms of its high durability, design, and quality

Durability	**Mean**	**Std. Dev.**	**Interpretation**
1. Wheels	3.29	0.99	Highly Durable
2. Handle	3.86	0.53	Highly Durable
3. Body	3.86	0.36	Highly Durable
Overall Mean	**3.67**	**0.63**	**Highly Durable**
Design	**Mean**	**Std. Dev.**	**Interpretation**
1. Wheels	3.57	0.65	Excellent Design
2. Handle	3.71	0.61	Excellent Design
3. Body	3.86	0.36	Excellent Design
Overall Mean	**3.71**	**0.54**	**Excellent Design**

Quality	Mean	Std. Dev.	Interpretation
1. Wheels	3.36	0.84	Outstanding Quality
2. Handle	3.71	0.61	Outstanding Quality
3. Body	3.79	0.58	Outstanding Quality
Overall Mean	**3.62**	**0.68**	**Outstanding Quality**

Table 7 shows that users are generally satisfied with the durability, design, and quality of the ergonomically designed cart, particularly its handle and body. The respondents expressed strong agreement regarding its durability and reliability. Likewise, the body's durability meets user expectations for strength and longevity. While the wheels received a slightly lower durability rating, users remained generally satisfied, although there is room for improvement in this area. Overall, the results suggest high satisfaction with the cart's durability across all evaluated components.

Users were also quite pleased with the cart's ergonomic design, which received high marks for each component's usability and comfort. The handle design is particularly praised for its ergonomic structure, which makes it easy to use. Furthermore, the body's design achieved the maximum rating, indicating significant satisfaction with the cart's overall build and appearance. The composite mean design score highlights the cart's ability to improve user experience by meeting ergonomic standards and functionality criteria.

These findings agree with studies by Garner et al. (2023), who emphasize the importance of ergonomic design in promoting user comfort and satisfaction. The study emphasized how the cart's strong materials, ergonomic grip, and well-designed body benefit individual users and community organizations. Susihono and Adiatmika (2021) also emphasized that ergonomic interventions significantly reduce physical discomfort while improving user satisfaction and performance. The data confirm the cart's practical benefits and user-friendly design and highlight the relevance of ergonomic interventions in improving usability, productivity, and community satisfaction.

Assessment of the various parts of the ergonomically designed cart in terms of its durability, design, and quality

Summary of Qualitative Findings on the Impact of Ergonomically Designed Carts

Below is the summary of the qualitative results derived from the responses of selected vendors on the impact of ergonomically designed carts in various categories. These categories include health and safety, productivity, user satisfaction, and durability. Each theme highlights specific benefits identified by the participants, highlighting how these carts contribute to improved physical well-being, enhanced work efficiency, and overall satisfaction. The study also explores how the cart design supports longevity and usability under various working conditions.

1. Theme 1: Health and Safety Statements
   Participants 3, 1, 5, 8, 9, 2, 14, and 7

   "Improving postures without back pain or numbing parts of the body while moving the cart." (Nakakatulong ito sa tamang postura nang walang pananakit ng likod o pamamanhid ng katawan habang inililipat ang cart.)

"Having more safety while using the cart." (Mas ligtas gamitin ang cart.)

"No more pain." (Wala nang pananakit ng katawan.)

"The handle fits my hands well, and I don't feel as much pressure on my wrists when pushing it." (Ang hawakan ay sakto sa aking kamay, kaya hindi masyadong napupwersa ang aking kamay kapag itinutulak ito.)

"Before using this cart, my back and shoulders would hurt every day. Now, I don't get as tired as before." (Madalas summit ang aking liked at balkan araw-araw. Ngayon, Hindi na ako madaling mapagod).

"I feel less pain." (Mas kaunti ang pananakit na nararamdaman ko.)

"It alleviates physical strain, improving posture and reducing pain." (Hindi nakakapagod agad, nagpapabuti ng postura, at nagpapabawas ng pananakit.)

"It improves body alignment and reduces the risk of injury" (Ito ay tumutulong sa mas maayos na katawan at safe.)

2. Theme 2: Statements on Productivity
   Participants 4, 13, 6, and 9

   "*I can move my cart faster and sell more in a day because I don't get exhausted so quickly." (Mas mabilis kong naitutulak ang aking kariton at nakakabenta nang mas marami sa isang araw dahil hindi ako agad napapagod.)*

   "*The materials are better than my old cart." Even with daily use, it still looks good and works fine." (Mas matibay ang mga materyales nito kumpara sa dati kong kariton. Kahit araw-araw gamitin, maganda pa rin ang itsura at maayos pa rin itong gumagana.)*

   "It allows for faster work, leading to better time management and task completion." (Nagpapabilis ng trabaho, maayos na oras ko at kumpleto ang trabaho ko.)

   "More organized and efficient work." (Mas maayos at tama ang proseso ng trabaho ko.)

3. Theme 3: User Satisfaction
   Participants 1, 4, 9, 11, 10, 12

   "There are many storage choices that can put utensils and coins." ("Maraming lalagyan para sa mga kagamitan at barya.")

   "Organized storage to create a workspace." (May mayos na malayan upang)
   Magkaroon ng sapat na espasyo sa paggawa.

   "Improving postures without back pain or numbing parts of the body while moving the cart." (Nakakatulong ito nang walang pananakit ng likod o pamamanhid ng katawan habang

inililipat ang cart.)

"I am satisfied with the carts' ease of use and comfort." (Masaya ako sa paggamit nito..)

"Having more savings, more sales, and more attractive customers every day." (Mas nakakatipid, mas mataas ang benta, at mas maraming kostumer araw-araw.)

"A separate proper chair with back support. The proper height and position of the bicycle saddle". (May hiwalay na tamang upuan na may suporta sa likod. Tamang taas at tamang posisyon ng upuang parang sa bisikleta.)

"It can give me proper and smooth work. Also, more storage or layers for the steamer, allowing me to add more food inside." (Nakakatulong ito upang maging maayos at mas magaan ang trabaho. May karagdagang lalagyan o patong para sa steamer, kaya mas maraming pagkain ang mailalagay sa loob.

"Overall satisfaction with ergonomic features contributes to better job satisfaction."
(Ang pangkalahatang gamit ay nakakatulong sa trabaho.)

4. Theme 4: Durability Statements
   Participants 1, 4, 11, 6, 8

   "Durable utensil storage and a clean workspace to have smoother work." (Matibay na lalagyan ng mga kagamitan at malinis na espasyo para sa mas maayos na trabaho.)

   "Requires less frequent repairs than traditional carts." (Matibay at mas tumatagal kaysa sa tradisyonal na gamit ko.)

   "Ideal for use under various environmental conditions." (Angkop sa iba't ibang kundisyon ng kapaligiran).

   "Good for long-term use and easy to clean." (Madaling linisin at mapapanatili para sa pangmatagalang paggamit.).

The responses of the participants highlight several key benefits of ergonomically designed carts, which are consistent with the study's objective to assess their impact on musculoskeletal health and productivity. These findings suggest that carts provide substantial advantages across various aspects of user experience. Regarding health and safety, participants reported reduced musculoskeletal strain, improved posture, and decreased fatigue, all attributed to the carts' thoughtful design. Davis and Kotowski (2014) emphasized that ergonomic interventions in the workplace are essential for reducing physical strain and promoting worker health. Consistent with this view, participants noted less pain and better body alignment. This ergonomic approach also serves as an effective coping strategy for managing both internal and external stress among community vendors (Aboh, 2024). In line with this, when evaluating the effectiveness of a job, one factor to consider is the work posture. An ergonomic and good working posture ensures that the operator produces high-quality output (Panjaitan, 2024).

Regarding productivity, users experienced increased efficiency, faster service, and a more streamlined workflow, all of which contributed to improved task management and productivity.

Prolonged work hours often lead to fatigue, which is a common issue for street vendors. The ergonomic carts provided practical solutions, enabling participants to conserve energy and focus on their tasks. As noted by Wilson (2000), ergonomically designed tools enhance worker productivity by minimizing physical and cognitive demands, a point reflected in the respondents' experiences. Additionally, the carts' improved workflow and efficiency were emphasized by participants who noted that the design allowed for quicker setups and task completion.

The user satisfaction rate was high, with respondents highlighting the comfort and ease of use, as well as positive feedback on features such as adjustable handles and smooth maneuverability. The findings underscore the role of ergonomic features in creating an organized and user-friendly work environment. Robertson and O'Neill (2003) argued that user-friendly equipment fosters positive attitudes toward work and promotes efficiency, affirming the study's findings. Participants recognized these features as key to their satisfaction and productivity, highlighting the role of ergonomic design in improving user experience. Additionally, sustainability enhances ergonomic practices by balancing present and future stakeholder needs across economic, social, and environmental dimensions, ensuring safe, efficient, and inclusive work environments (Parvez, 2024).

Additionally, the carts' durability and ease of maintenance were emphasized, with users appreciating their long-lasting design, resistance to wear and tear in harsh conditions, and low-maintenance requirements. Overall, the ergonomic features of the carts were seen as a significant factor in enhancing both the physical and operational aspects of the users' work environments.

Overall, the results of both quantitative and qualitative research consistently present how ergonomic carts improve users' health, productivity, durability, and satisfaction. The carts allowed for more productive work, better posture, and less strain. They also enhanced long-term usefulness and financial gains, confirming their importance as vital tools for vendors.

CONCLUSIONS

Ergonomically designed carts significantly improve the efficiency, comfort, and overall well-being of street vendors, enabling them to work more effectively and with greater ease. The demographic analysis highlights the importance of considering gender- and age-related ergonomic needs in cart design. Most users are middle-aged women; however, most vendors are men, emphasizing the necessity of inclusive designs that accommodate diverse user needs.

The study further reveals that the use of ergonomic carts has improved productivity, efficiency, and time management, as evidenced by higher user satisfaction and increased earnings. The carts have also contributed to reducing musculoskeletal strain, improving posture, and minimizing fatigue, which is consistent with research on workplace ergonomics. These improvements directly support Sustainable Development Goals (SDGs) related to health (SDG 3), decent work (SDG 8), poverty reduction (SDG 1), and sustainable production (SDG 12).

Additionally, ergonomic carts have positively influenced financial and operational efficiency by reducing vending costs, optimizing tool usage, minimizing waste, and enhancing workplace organization. These benefits translate to improved economic opportunities and better working conditions for vendors, reinforcing the role of ergonomic interventions in sustainable livelihood development.

Overall, the study underscores the necessity of ergonomically designed equipment for physically demanding occupations. The findings suggest that continued investment in ergonomic solutions can lead to improved occupational health, increased efficiency, and economic growth. Future studies should explore further enhancements in ergonomic cart design to maximize the benefits for all users

LIMITATION & FURTHER RESEARCH

Despite the documented benefits, research on the long-term effectiveness and user satisfaction of ergonomic carts in real-life applications is still limited. Future research could offer deeper insights into their advantages and potential for wider adoption. Further studies should also examine the impact of adjustable ergonomic features, such as handle height, wheel size, and load distribution, on user comfort and efficiency. Another underexplored area is the long-term durability and economic feasibility of these carts. Future research should assess real-life wear and tear over extended periods to investigate how materials, maintenance costs, and usability evolve. This will help determine whether ergonomic carts will remain a cost-effective investment for street vendors eventually.

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