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Adoption of Compact and Affordable Product Sorting Systems in Small Indian Enterprises: A Techno-Managerial Perspective

Ganeshdev Sahadevan
Department of Psychological Sciences, School of Human Sciences, Central University of South Bihar (Gaya), Bihar, India, E-Mail: ganeshdevsahadevan@gmail.com

ABSTRACT

The sorting systems within the small enterprise sector are emerging and inevitable nowadays. Product detection and sorting technologies significantly enhanced the delivery process within small enterprises, resulting in increased productivity in retail markets, mini-markets, and other small-scale businesses. This perspective paper focuses on the implementation of a compact and affordable product detection and sorting conveyor system for small-scale enterprises. Further, examining the sorting system and its impact on employees through a managerial lens, and addressing the adoption of sorting systems by employees of small enterprises. Subsequently, this perspective emphasises the importance of compactness and affordability of a sorting system that requires minimal materials, while also contributing to the adoption of sorting systems within small enterprises, particularly in developing countries. It is advisable to create a leadership approach and practical learning, Training, and development based on human-system interaction strategies. Furthermore, affordable and straightforward sorting systems that incorporate human interaction strategies will enhance the adoption of sorting systems among employees in small enterprises.

Keywords: *Affordable, Product Detection, Sorting Conveyor, Small Enterprise, Leadership, Strategic Management.*

1. INTRODUCTION

In many industries, the sorting of manufactured products or the delivery of products is done manually, utilising labourers, particularly in small-scale enterprises. It is essential to implement effective sorting systems and improve the management of these systems and employees across every industry, enterprises is crucial, In this modern era, humans are highly interacting with machines and different technologies, so it is essential to look upon the management and leadership scenario in between the technology and employees, here the technology we are discussing is the sorting systems focusing on the small enterprises within the developing countries, because developing countries are nowadays struggling to implement modern technologies, so the initial capital investment and the compactness of the entire system is a concerning factor also the scenario of employees within enterprises. A sorting system has many benefits in terms of productivity and cutting labour expenditure, as well as human error in the process of sorting. Moreover, the systems could support the company with important information on the control of inventory or supply chain and therefore a critical module of the business. By considering the economy of the developing country, the feasibility and implementation capability of such sorting automation and systems is nearly impossible because of one of the essential factors, that is, the initial huge capital investment of the small enterprise.

This perspective presents a product detection and sorting conveyor equipped with a robotic arm as a solution to manual sorting, thereby reducing the number of employees in the sorting process within small-scale enterprises and industries. According to previous research works, the sorting systems are equipped with a high-resolution camera positioned above the mechanical conveyor belt. Using images taken by the camera to analyse and identify the features of the object (Adekeye et al., 2024; Hanumanthu et al., 2024; Shalini et al., 2023; Tho et al., 2016). This perspective article is based on the research work conducted by Sahadevan et al (2025), Design and Development of a Compact and Affordable Product Detection and Sorting Conveyor System for Small-Scale Enterprises, which is more technical and engineering-focused. Still, here in this perspective paper, we emphasise the

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implementation obstacles and managerial perspective of the sorting conveyor system (Sahadevan et al, 2025).

Table 1 shows a brief overview of the essential components or items required for the development of a compact and affordable sorting system. In this table, the miscellaneous expenses, maintenance costs and labour costs are not included, because the manufacturing companies of sorting systems and the enterprises can make further decisions upon these

2. TECHNO-MANAGERIAL PERSPECTIVE: A SIMPLIFIED PRODUCT SORTING SYSTEM

expenses through the involvement of the state or central government or other mediators for the sorting system development and implementation within the small enterprise, the prices are negotiable with each of the item manufacturing companies according to the needs and preferences between both sorting system manufacturing companies and enterprises.

Table 1: Simplified List of Materials with Approximate Costs

SI No.	Component/Item	Functional Purpose	Quantity	Estimated Unit Price (₹)	Total Cost(₹)
1	T-slot frame	Structural base support	2	200	400
2	Stepper motor (NEMA 17)	Motion control unit	3	700	2100
3	Smooth rods	Linear motion guide	3	433	1300
4	Leadscrews	Mechanical drive system	2	450	900
5	Rail support & Plummer block	Stability and alignment hardware	5	276	1380
6	Couplers	Connectivity between shafts and motors	2	300	600
7	Aluminium block	Mounting and support structure	1	150	150
8	Linear bearings (with housing)	Smooth linear actuation	6	303	1820
9	Arduino + CNC Shield	Central control system	1	750	750
10	Raspberry Pi	Edge computing interface	1	1400	1400
11	Worm gear motor	Load-bearing motion drive	1	3000	3000
12	PVC pipe and Nylon sheet for the Conveyor system(3 meters each)	Material transport medium	1	1350	1350
13	UV sensor	Product detection/sorting	1	150	150
14	Position sensor	Conveyor alignment monitoring	1	100	100
15	SMPS (power supply)	Centralized power unit	1	600	600
	Total				16000

Source: Author's Work

Note: Prices are indicative based on 2025 market estimates in Indian Rupees (INR). Actual cost may vary by region or vendor. The table above is intended for conceptual understanding and managerial decision-making, as well as to assist small enterprise managers and system integrators.

A cylindrical robotic arm attached to a conveyor belt mechanism, which can be customised according to the needs of small enterprises, is used here. This arm can rotate 360 degrees and is capable of picking and placing objects in desired destinations. Figure 1 represents the conceptual diagram of the entire sorting system, which can be further customised according to the needs and preferences of the small enterprise.

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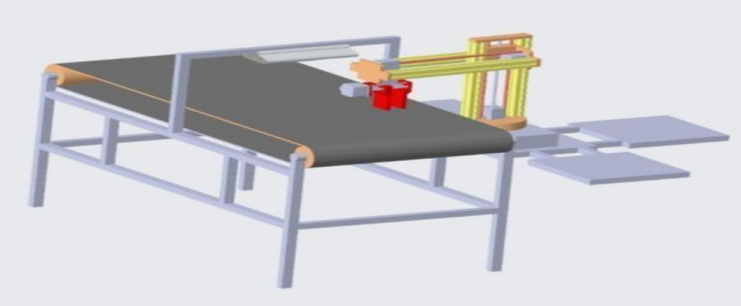
Figure 1. Conceptual Diagram of Product Sorting Conveyor System for Small Enterprise Application



Source: Author's Work

2.1. Employee Interaction with Product Sorting System and Management Scenario

Nowadays, employee interaction between various systems within the enterprise is becoming more crucial because this is associated with the well-being of the employees in a broader sense, so the application of strategies is essential within a small enterprise. According to Sharma et al (2024), an automated waste-sorting system that utilises object-detection technology to enhance waste management processes and this system boosts recycling rates, minimises contamination, and includes a reward system to promote responsible waste disposal behaviours among users (Sharma et al., 2024). This is a practical application of gamification in the enterprise or industry. Gamification has a lot of merits in the modern technology and human interactions with technology, gamification is the application of game like elements within the management of employees who are interacting with technology to develop an engagement or reward based satisfying engagement of employees within the scenario of human technology interaction, another study introduces a laboratory sample sorting management method that involves reading sample bodies and electronic tags, tracking transfer information, and adjusting sorting outcomes to improve accuracy and efficiency in sample management, addressing existing operational shortcomings (Haipeng et al., 2020), gamification can be applied as a more efficient management scenario or strategy in the context of the small enterprises to create the leadership strategies, so there one can also implement the elements of the gamification, one more study is the sorting management based on a slotting approach that incorporates SKU(Stock Keeping Units) physical variables and warehouse design, thereby optimising the space allocation and maximising order-picking efficiency to minimise logistics costs and consequently improve the overall warehouse performance (Duque-Jaramillo et al., 2024). Göbel (2022) highlights the impact of cooperative relations between works councils and management on the sorting outcomes, specifically by enhancing pay transparency, which in turn boosts employer appeal and reduces turnover. This relationship underscores the significance of effective management practices in shaping employee sorting within organisations (Göbel, 2022).

Furthermore, Alamsah et al (2024) emphasised that 'Warehouse Management Systems' (WMS) are used to enhance operational efficiency and improve inventory accuracy, emphasising the importance of cost-benefit analysis and technical support in WMS(Warehouse Management Systems) selection (Alamsah et al., 2024). The importance of aligning warehouse management with organisational goals has been emphasised in a recent study conducted by Mrabti et al (2024) (Mrabti et al., 2024). The importance of training and maintenance programs for effective warehouse operations, which can be indirectly related to managing both systems and personnel in automated environments (Odeyinka & Omoegun, 2023). Sarker (2025) reviews the use of information technology, which is sorting technology, in improving employee productivity and job satisfaction through an improvement in decision-making, workflow and time management.

A case of the use of the aspect of gamification is hereby observed. However, technological overload and erroneous training, which may come along with it, can be made up of the targeted individuals who can be halted in their way of enhancing employee performance. It has the capability to make people more decision-makers and productive. It will require proper planning and training to work effectively (Sarker, 2025).

Aziz & Osman (2025) highlight the factors such as the work environment, stress, and training within the electrical and electronic manufacturing industry in Malaysia (Aziz & Osman, 2025). This is an emerging issue in current human-technology interaction scenarios. According to the studies conducted by Abiodun & Isibor (2024), which highlight the effects of digitalisation, such as telecommuting and improved work-life balance, which enhance productivity, do not explicitly mention sorting technology; rather, the human interaction with technology is more concerning here, specifically, employees interacting with sorting systems and their perceptions of sorting technologies. Digitalisation boosts employee productivity through job autonomy and work-life balance, and telecommuting enhances productivity levels in organisations (Abiodun & Isibor, 2024). There are both positives and negatives associated with digitalisation, and addressing these issues related to negative aspects is essential from a technological perspective, particularly in terms of leadership and management of employees regarding human interaction with technology. Therefore, it is preferable to frame a strategic leadership scenario based on human system interaction. Duică et al (2024) highlighted that the adoption of sorting technology affects managers by necessitating adjustments in management approaches and increasing technical skills. They also value the role of emotional intelligence to further support employees through digital transformation, which impacts various organisational functions (Duică et al., 2024).

2.2. Strategic Implications for Small Enterprise Managers

This perspective paper focused on a simple, small, and inexpensive product detection and sorting conveyor system, with an aim of looking into the small enterprises of developing countries. The rationale is that the availability and affordability of sorting product technology will provide a great opportunity to make the sorting systems available to small enterprises at a low initial cost of capital. Also, this prospect looks into some of the most basic aspects of the simple design with less material selection and construction based on cost effectiveness, so that the whole system fits comfortably within different small enterprises, which in turn will have a social and economic impact within the society. With such smaller and economical designs in place, even small businesses can afford to introduce sorting systems, which consume a minimum number of materials, and allow small enterprises to improve their businesses without having to cut their financial resources short. This article shares an idea of an automated way of sorting the products in the context of small enterprises, the design of the product, and taking up the product in terms of cost. The sensor-based robot handling systems that make the robot pick and place an object will work well if the systems are well-designed and developed.When comparing the benefits and disadvantages of sorting systems applied to small businesses, it is clear that much attention should be given to the implications of the usage of both the advantages and the drawbacks scenarios within a small enterprise perspective. Subsequently, these systems have the potential to increase operational effectiveness and precision, but may also cause major transformations in the balance of the working force and the definitions of the jobs. In order to address the risk of adverse effects, the companies are recommended to pay attention to delivering a comprehensive training program, creating new job opportunities that utilise the critical thinking skills in the employees, and ensuring a supportive work environment during the transition period towards automated sorting procedures. Moreover, the sorting technology may have wider consequences towards organisational culture and structure of the small businesses. It can require the modification of the management style, communication practices, and decision-making procedures, which eventually leads to a more flexible and data-driven workplace.

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The effort to introduce sorting systems to small enterprises introduces a confusing trade-off relating to operational efficiency and employee welfare, where the negative and positive implications of such practices should be duly considered for the employees. The strategic job rotations, upskilling opportunities, and extensive training that aim to promote the critical thinking skills of employees and their technological literacy should be prioritised by companies to address the possible disadvantages. Through this moderate position, small companies can take the best out of the integration of sorting technology and still have a more flexible and happy workplace, with the final effect of increasing overall productivity and competitiveness of the organisation. Small enterprises, especially those in developing countries, could have great impacts economically and in terms of efficiency when simple and inexpensive product detection and sorting systems are implemented. This technology might also help the smaller enterprises to compete better, and as a result, more productivity, better inventory and the process of decision-making might take place. But the implementation of such systems brings a risk of job loss and shifts in labour forces, which is to be taken into consideration carefully, with respect to social and economic effects. In order to maximise the advantages and reduce the possible negative impact, the companies can be required to pay attention to employee training, changes of jobs, and the utilisation of higher-order thought processes of workers, other than manual sorting. Moreover, the implementation of gamification in the sphere of management and training may be also used to maximise the efficiency of operations and improve leadership in these small businesses.

Increasing the operational efficiency of the managers can be done through the sensible use of gamification in enterprises or industries and also with its applicability to the workforce. In the future management scenarios, it will be possible to apply the elements of gamification to serve as an effective measure, supporting the process of leadership development within the small enterprises. Gamification can also be used in learning, training and development of employees. The collaboration of the workers and managers has a large role to play in the outcomes of sorting. Sorting systems are very important in terms of improving operational efficiency and accuracy of the inventory, and that is why it is essential to carry out a cost-benefit analysis to ensure the most suitable means is identified. Sorting technology can lead to improved employee productivity and job satisfaction due to improved decision making and efficiency of work, but it will also affect job satisfaction negatively, such as the risk of job displacement, stress caused by changes of roles as mentioned before, worries regarding job security and time management. Though the use of sorting systems raises efficiency, accuracy and productivity of small businesses, this can also provoke job displacement, which results in loss of job and emotional disturbances. In this example, the workers can be rotated to the jobs which are more concerned with the choice and critical thinking and to certain extent, it will allow the workers to exercise their higher order thinking abilities in the small companies and it will bring the level of productivity of the enterprise up to a high notch compared to the typical sorting tasks settings especially in the lead and management areas as far as the knowledge on people and technology deals. Better training opportunities might be designed to deal with that subject, and this will bring benefits to both the workers and the enterprise in general.

3. CONCLUSION AND FUTURE OUTLOOK

This perspective paper presents a straightforward approach for developing a compact and affordable sorting conveyor system, specifically targeting small enterprises from a techno-managerial perspective. It emphasises the system's low capital investment, ease of placement, and potential to enhance adoption and familiarity with sorting technologies within developing countries. Furthermore, collaboration between product sorting system manufacturing companies, the government, and small enterprises could facilitate knowledge transfer and technical support. Moreover, it is advisable to develop a strategic leadership approach based on human-system interaction. Practical training and strategic leadership should emphasise human-system interaction. Leadership commitment significantly enhances employee satisfaction, and further advancements in product sorting technology affect managers by requiring changes in management strategies and improving technical

skills. Managers need to demonstrate emotional intelligence to support employees during technology transformations, which involve various enterprise functions and processes. Additionally, managers must emphasise the technology leadership scenario.

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