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SUSTAINABLE FRAMEWORK FOR IMPLEMENTING ROBOTICS IN A DEVELOPING ECONOMY: PROSPECTS AND CONTRAINTS

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ABSTRACT

Service robots and artificial intelligence promise to increase productivity and reduce costs, prompting substantial growth in sales of service robots and research dedicated to understanding their implications. To establish some fundamental insights related to this research domain, this paper seeks to complement research on robots' human-likeness with investigations of the factors that service managers must choose for the service robots implemented in their service setting. A three-part framework, comprised of robot design, customer features, and service encounter characteristics, specifies key factors within each category that need to be analysed together to determine their optimal adaptation to different service components. This framework and the final research questions provide a research agenda to guide scholars and help practitioners implement service robots successfully. This paper seeks to develop a practical and systematic framework for the implementation of robotics and similar technologies in a developing country. The methods developed towards achieving this objective include: surveying the available literature on automated assembly systems; defining the advantages and limitations of the various systems; studying different classifications and programming methods of Industrial Robots with a view to examining their effectiveness in a viable and efficient automated assembly system. Particular attention is given to the need to justify capital investments prior to introducing automation into any production processes. In this context, the sociological impact of robots with respect to job enrichment and displacement, quality of life, and economic emancipation are discussed. Of particular focus is the role of robotics in eliminating dangerous or undesirable ' jobs, increasing product quality, manufacturing flexibility, output rate, and efficiency

Key words: Automation, Efficiency, Investment, Manufacturing, Robotics

1.0 INTRODUCTION

The rise of robots, a decades-long process throughout many sectors, has finally reached service industries. Advanced robotics, and artificial intelligence (AI) enable providers to offer their services with greater productivity, efficacy, and efficiency. (Wirtz et al., 2018). A survey to business leaders reveal that 24% of US companies are already using AI, and a 60% expect to use it by 2022 (Genesys, 2019). From the customer domain, 62% of users of voice-based digital assistants plan to have these smart devices within the next few month (GoGulf, 2018). Sales of service robots continue to grow at annual rates of greater than 30%, and the International Federation of Robotics (2018) anticipates even greater expansions in the use of service robots for professional and personal purposes in the next decade.

The social, economic, and labor consequences of this spread of robots are thus pertinent questions. In particular, automated agents increasingly will replace human employees, even in complex, analytical, intuitive, and empathetic tasks (Huang & Rust, 2018). Yet marketing studies of service robots remain scarce, and just a few theoretical works consider the distinctive features of related technologies and their global implications (Huang & Rust, 2018; Wirtz et al., 2018). More importantly, we know of no existing frameworks designed specifically to help researchers set up meaningful conceptual frameworks for their study and at the same time help practitioners increase the likelihood of a successful introduction of service robots. With this study, we seek to bring more structure to a topic of emerging relevance by outlining a framework for future studies and decisions on robots in the frontline of organizations. We start by reviewing previous literature to identify key concepts and origins and thereby establish a foundation for understanding fundamental features of service robots. We illustrate this three-part framework by providing actual examples of AI and robotic agents currently at service, and explaining the existing research knowledge, often insufficient, related to each aspect. -part framework when introducing robots into their specific service contexts. To a large extent, our research contributes to organize previous knowledge on the emerging phenomenon of service robots around a useful framework indicating the key factors to be researched by scholars in order to help practitioners succeed in the implementation of service robots.

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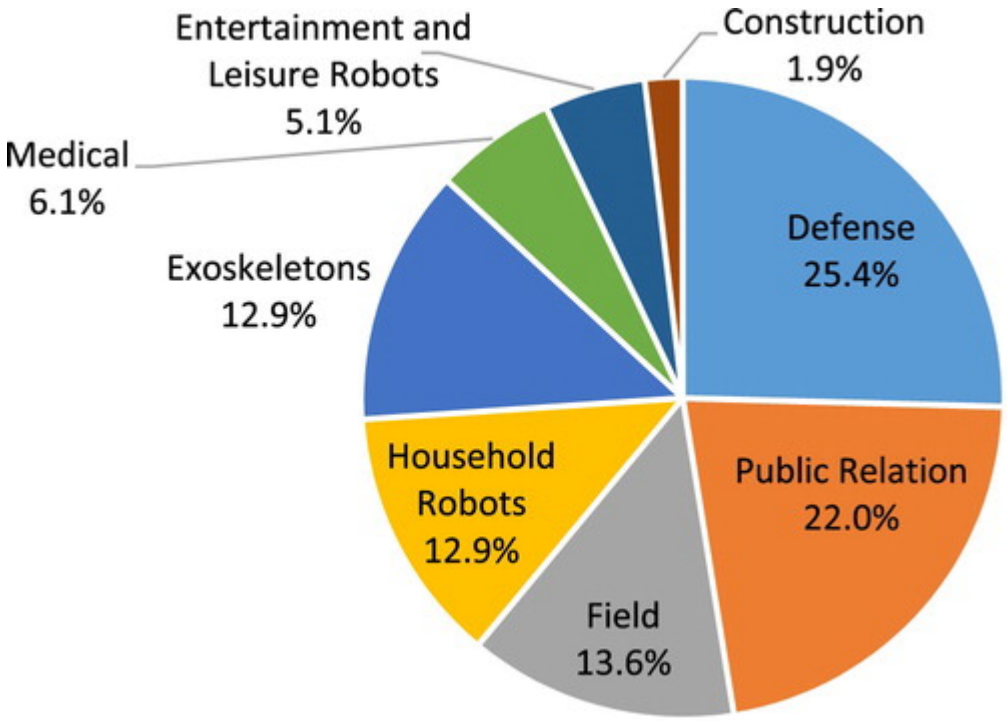

Figure 1. Sectors of global sales of service robots in 2017 (excluding logistics). Source: International Federation of Robotics (2018).

2.0 METHODOLOGY

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2.1 SERVICE ROBOTS: CONCEPTS AND DEFINITIONS

As a result of the nascent status of this research domain, defining the terms used to describe similar concepts is a critical and necessary effort, to establish the limits of the field and which approaches are most relevant. In particular, *robot* is a standardized, general term, though several overlapping concepts also can describe robotic entities. Derived from the Czech word *robota*, which means 'forced labor' or 'slavery' (Capak, 1920), robot also can describe mechanical devices programed to perform specific physical tasks. It implies some level of autonomous action, without human intervention (International Federation of Robotics, 2016), though this level of autonomy varies widely, from a robotic arm performing a repetitive manufacturing task to the Curiosity robot that has been exploring Mars for more than six years. This paper seeks to bring attention to a topic of growing relevance and provide a framework to guide and stimulate further research into the expanding introductions of service robots. Each component in the proposed framework sparks research questions, and together, these questions constitute a viable research agenda. In particular, recent research suggests that the elements of our framework influence service performance, customer satisfaction, customer-robot and customer-employee rapport building, and employees retention, among other

Fig 2. Key customer features for service robots.

Fig 3. Key factors of service encounter characteristics for service robots.

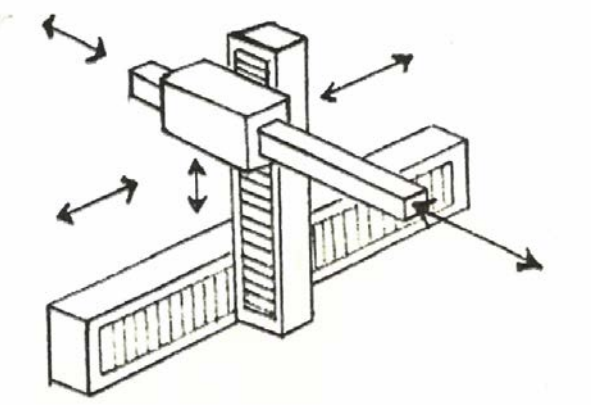
important management indicators (Fan et al., 2019; Prentice et al., 2019; Qiu et al., 2019). By using the definitions and references we have offered to develop our framework, researchers can continue to investigate each element in greater depth. Scholars' research should help managers decide which combination of robot design, customer features and service design characteristics leads to a better implementation of service robots in their context.

2.2 TOWARD A NEW FRAMEWORK FOR A NEW FIELD OF RESEARCH

As this definitional effort indicates, robots are technological entities with some human features. In service settings, previously inhabited by either machines or employees, a service robot represents something in between, with technological features but also the ability to engage in human interactions. Service robots also operate autonomously, directed by AI without needing instruction or human help unlike technologies that require employees' or customers' effort. Consequent of the fact that service robots combine advanced forms of intelligence (mechanical, analytical; Huang & Rust, 2018), they also can perform complex tasks that previously required human intelligence (Tussyadiah & Park, 2018). Considering these unique features, we need to integrate the robot's design features, such as whether it can respond to social cues, with customers' own features and perceptions and with service encounter characteristics that inform the structure and success of a service provision episode.

2.3 Robot Types, Classifications and Geometric configuration

Robots are classified based on the following: Geometric configuration; Drive; Control; and Programming method



(a) **Cartesian/ Rectangular**;

Fig 4: Rectangular Geometric Robot: This type is used in Assembling operations; pick and place; seam welding; spot welding and machine tool servicing

(b) Polar/Spherical

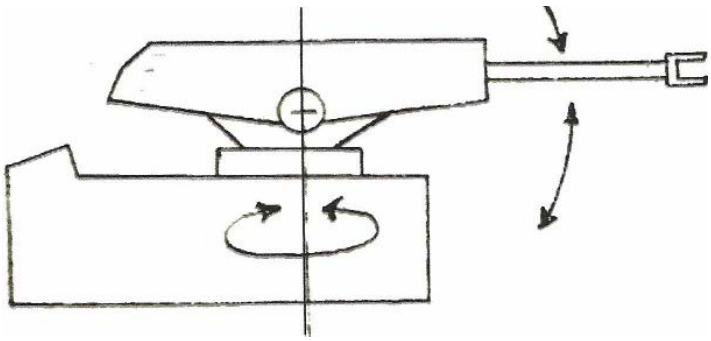


Fig 5: Polar/Spherical Geometric Robot: used in pick and place; die casting.

Cylindrical

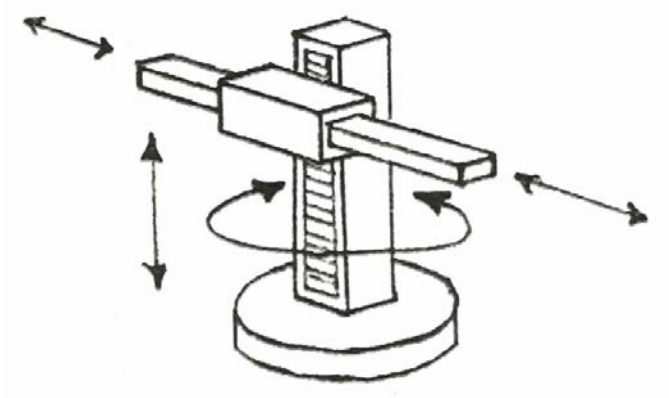


Fig 6: **Cylindrical Geometric Robot**: used in pick and place and assembly etc

(c) Jointed arm/ Revolute

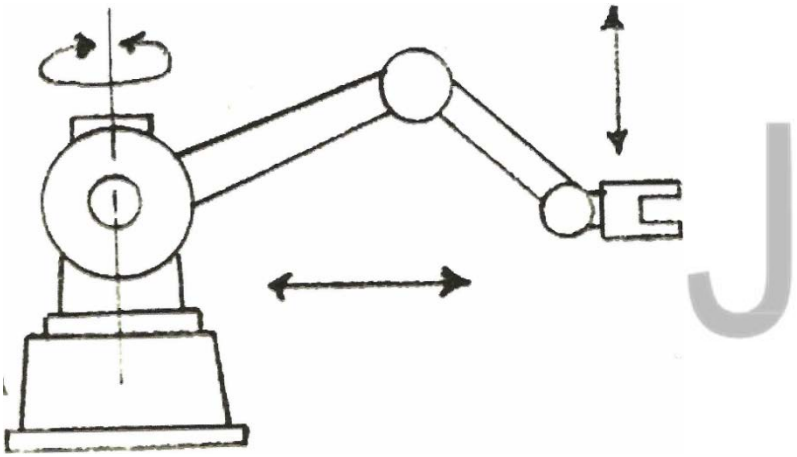


Fig 7: Jointed Arm/Revolute Robot: used in castings, die-burring and spray painting.

2.4 Drive methods

Hydraulic: High power to size ratio obtained with hydraulic activators and motors; It is however less reliable than other types and Hydraulics servo-systems control is more complex

Pneumatic: This is the cheapest form of drive; the components and compressed air are usually readily available.

Electric: The motor is usually higher than its hydraulics counterparts. It however has some Challenges, it is not intrinsically safe and some sort of mechanical transmission usually adds to mass, which may complicate control

Control method: (a) Servo/non Servo (b) Continuous Path/point to point

2.5 ROLE OF ROBOTS IN DEVELOPING COUNTRIES

Another critical decision in designing a service robot is whether customers should know that they are interacting with a robot, because robot notification makes it clear to them. Although this decision is especially important in robots whose mechanics are not visible to customers, robots' appearance becomes increasingly natural and may be indistinguishable from a human in future. If humans cannot conclusively determine that they are talking to a machine, they are less aware of an artificial interlocutor in a service context. Customer awareness may involve several levels (social, task, job awareness) that can evoke different inferences, thoughts, and reactions (Drury, Scholtz, & Yanco, 2003). To avoid negative consequences, service companies must consider various possibilities: notify the customer upfront. Several organizations are engaged in a race to design an indistinguishable robot with a nearly perfect human look.

Robot has played an undisputable role in the economies of the developed countries, with the attendant benefits to the companies using it. (Bartneck et al.92007) These benefits include: elimination of dangerous or undesirable jobs; increased product quality; flexibility; output rate and increased efficiency

Elimination of tedious and dangerous Jobs - Many jobs, such as in assembly lines, provide working conditions that are either hazardous or repetitive.

Increased manufacturing flexibility - Flexible manufacturing, attempts to achieve the best features of flexible automation and fixed automation. Flexible Manufacturing System (FMS) implies the use of programmable, computer controlled equipment and industrial robots.

Increased Product Quality / Efficiency – Consequent of the fact that they are consistent, robots help reduce both inventory and scrap. In the automotive industry, the search for product quality has been a major motivating factor in the decision to invest in robotics. As robots help to produce to greater consistency and conformity to quality specifications

Increased Productivity - In general, high production rates are achieved with automation than with the corresponding manual means. As a rule of thumb, a robot used in machine loading or material handling applications will result in a 10 to 12 percent increase in throughput over a human operator. Drury et al. (2003)

Other economic benefits include: Reduced labour cost; Greater throughput in the same faculties; Less scarp and rework; Material saving; Power saving; Lower handling cost; Improved management control; Lower inventory cost; Increased flexibility for product or

design changes; To remedy high labour turnover problems; Best capital investments

2.6 THE MAJOR CONSTRAINTS IN ROBOT IMPLEMENTATION

Successful implementation of robotics in developing countries requires not only a carefully studied plan, but also a set of prerequisites.

2.6.1 Power Supply

It is not unusual in many developing countries to find a weak, unpredictable, corrupted or rationed power supply replete with voltage surges and sometime outright blackouts.

2.6.2 Information Systems Technology

Robotics is only one element in the spectrum of automation technology. It has to be augmented with, and supported by, information systems technology

2.6.3 Skilled Operators and Technicians

Developing countries are known for harsh environmental conditions. Consequently, equipment breakdown is more frequent than in developed countries. As a result, good technicians are required for successful implementation of robotics in developing countries.

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2.6.4 PROSPECTS OF ROBOTS IMPLEMENTATION IN DEVELOPING COUNTRIES

The level of automated social presence also might alter the level of human social presence Warnecke et al. (1980). That is, technology may be substituting for frontline employees or complementing their efforts to facilitate the encounter. Even if the service outcome of both interactions is similar, customers likely behave differently, depending on their perceptions of the interacting agent, robotic or human. Employees-AI collaboration help build customer-employee rapport though, recent evidence in hospitality found that AI harms the productivity of emotional intelligent employees (Prentice et al., 2019). Huang and Rust (2018) suggest that companies thus must offer dual service provision:

The developed countries have reaped, and will continue to reap, significant benefits from implementing industrial robots. The same opportunity is available for the developing countries that decide to embrace the technology.

2.6.5 Improved Economic Status

The developing countries stand to benefit from robotization in the long run, with the favorable overall economic benefits resulting from implementing the Robot Technology.

2.6.6 Improved Standard of Living

As the economy improves and expands, more jobs are created, existing jobs *are* better rewarded, and per capita income is thus increased.

2.6.7 Increased Level of Competence

With the improvement in economic conditions, a door is open for a developing country to improve its level of competence in two critical areas: Technical and military.

2.6.8 Economic and Political Independence

It is a sad reality that most developing countries, even though formally independent, still cannot make their own decisions in many economic and political: circumstances.

3.0 DISCUSSION

This paper seeks to bring attention to a topic of growing relevance and provide a framework to guide and stimulate further research into the expanding introductions of service robots. Each component in the proposed framework sparks research questions, and together, these questions constitute a viable research agenda. This research contributes to review and organize previous knowledge in order to help researchers and practitioners address the key elements affecting a satisfactory introduction of service robots. Although it is beyond the scope of our proposed framework to offer a holistic model of all potential determinants of the success of a service robot implementation effort, we identify some essential factors, with clear managerial implications. In particular, recent research suggests that the elements of our framework influence service performance, customer satisfaction, customer-robot and customer-employee rapport building, and employees retention, among other important management indicators (Fan et al., 2019; Prentice et al., 2019; Qiu et al., 2019). By using the definitions and references we have offered to develop our framework, researchers can continue to investigate each element in greater depth, as variables in unique research projects.

4.0 CONCLUSION AND RECOMMENDATIONS

This paper seeks to bring attention to a topic of growing relevance and provide a framework to guide and stimulate further research into the expanding introductions of service robots. Each component in the proposed framework sparks research questions, and together, these questions constitute a viable research agenda. This research contributes to review and organize previous knowledge in order to help researchers and practitioners address the key elements affecting a satisfactory introduction of service robots. Although it is beyond the

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