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Cobots Implementation in the Era of Industry 5.0 Using Modern Business and Management Solutions

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ABSTRACT

The paper describes the possibilities of implementing cobots for the execution of manual tasks in human-cobot collaborative teams to reduce waste within manufacturing systems from the perspective of Industry 5.0. Particular attention is paid to those manufacturing systems where, due to the high costs of possible reorganization, cobots are implemented in the existing system without significant modifications. The work is carried out in collaboration between humans and machines. To illustrate proposed implementation model, a conceptual use case (concept case) corresponding to an actual furniture manufacturing process was developed. The identification of the space for the use of cobots was verified using the value stream mapping method, and the implementation possibilities were analyzed using dedicated simulation software. The production process was mapped in both the value stream map and the simulation software. The potential for time savings in the implementation of the production process and a potential increase in the average production volume were demonstrated. Thus, the implementation possibilities of the presented concept were positively verified. The presented approach forms the basis for innovative solutions based on an interdisciplinary combination of organizational, management, and technical issues from the perspective of cobot use. This offers the opportunity to develop a cost-effective solution for implementing modern cobotic system technology to reduce waste in line with lean management. The concept opens up the perspective for many questions in terms of how and when to implement a cobotic systems solution in an organization. This is particularly relevant from the perspective of a company operating in a specific industry, using selected technologies and work organization methods.

Keywords: outsourcing, cobots, lean management, VSM, Industry 5.0.

INTRODUCTION

Modern technology is undoubtedly having an impact on businesses. With the advent of successive improvements, companies are generating more and more profits, improving the quality of production or creating new products. With the arrival of the third and subsequent industrial revolutions, IT system solutions have been permanently adapted to the needs of business entities. On the other hand, changes within companies are also implied by new ways of organising work or cooperation within capital groups or various types of partnerships. New ways of performing tasks have emerged, both internally and in the organisation's external environment. There are many methods of implementing modern technological solutions, including external outsourcing, purchase or in-house outsourcing, as in the case of the aforementioned capital groups [1]. The decision related to the purchase of a new technology involves a number of risk factors regarding the success of the implementation activities and the costs that go with them.

From the perspective of the industrial revolution, in particular, Industry 5.0 [2,3], a new perspective is opening up for companies in the use of collaborative robots (collaborative robots, cobots). The use of such devices cooperating with humans directly on the shop floor applies to both business-critical and auxiliary processes [4] (Fig. 1).

As the concept of cobotic systems is relatively new, it raises many questions both in terms of specialized, implementation, but also organizational or management solutions. This is a research gap identified by the authors. Therefore, this article presents concepts for the implementation of cobots in organizational and management terms, indicating both tools and possible implementation models. The presented course of action is to present a path for the implementation of a cobotic system in a manufacturing system using dedicated simulation, business, and management tools. The steps shown, due to their organizational-management nature, are the same for different types and kinds of cobots.

To present application recommendations for business conditions (implementation model), organizational tools (VSM) [6,7], and identification of tasks (activities) dedicated to cobots, a concept case was developed. Its purpose is to illustrate the impact of the operation of the presented solutions on the efficiency of the manufacturing system. Particular attention was paid to those systems where, due to the high cost of possible reorganization, cobots are implemented in the existing manufacturing system.

Cobots and Industry 5.0

Collaborative robots are dedicated to direct interaction with humans, where manufacturing

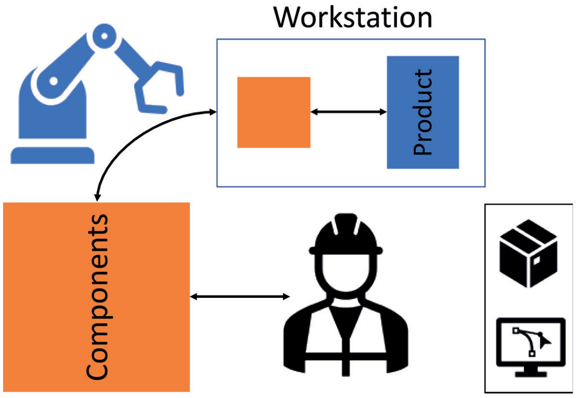


Figure 1. Human – cobot assembly system [5]

tasks are carried out together [8]. Cobotic systems are clearly different from autonomous industrial robots as they are not isolated from humans. They operate in the same workspace as humans. This feature, i.e. the ability to combine the strength of the cobot together with the sensitivity and dexterity of the worker, is the source of many benefits in terms of ergonomics, productivity [9] or safety.

The end state is both the acquisition of a cobot and its successful implementation [3]. Each cobotic solution must be properly configured (series of tests) and tailored to the needs of the task (data collection). As part of this process, machine learning [10–12] is carried out to develop cobot control algorithms adequate to the conditions of the working environment as well as the capabilities of the machine. For these reasons, implementation is a dedicated, highly specialised service. It also carries the risk of failure if reliable data cannot be obtained [13].

The implementation of a cobot on the production floor involves a series of tasks as well as costs. Key costs include: the cost of the cobot, the cost of installation (adapting the machine environment), the cost of training the cobot (data collection), the cost of training employees, the cost of maintenance (maintenance/repair), the cost of use (electricity) and the programming costs associated with operating the cobot [14]. Therefore, the decision to implement this type of solution requires analysis and involves an investment risk for the company. The investment should be long-term.

A fundamental question arises: which elements of the manufacturing system can be supported by cobotic systems [4]. As the literature indicates, this is particularly relevant for manual jobs. This type of job, which relies on the skills and availability of workers, can relatively easily become a bottleneck in their absence. This situation can occur in the following cases:

- replacing an absent, trained, highly skilled worker with a new one who has to learn the job from scratch;
- a human-induced production error, which results in the need to repair or rework individual product components;
- physical limitations of workers (e.g. fatigue, loss of concentration, routine), which affects the speed and quality of work;
- the need to remove quality defects from previous jobs.

It is expected that the integration of a cobot into a manual workstation will relieve the worker of some of the work and increase productivity by preventing the workstation from becoming a bottleneck [15].

The issue of cobot deployment forms the basis for the implementation of Industry 5.0 solutions. Industry 5.0 is defined as a human-centered design solution in which an 'ideal' human and cobots collaborate with various resources in an organization to enable personalized, autonomous production through corporate social networks [16,17]. Cobots are not programmable machines but can identify and understand human presence. In this context, cobots will be used for repetitive tasks and labor-intensive work, while humans will take over personalization and critical thinking tasks [18].

Industry 5.0 redefines the workforce, where man and machine work in joint interaction to increase process efficiency. This is done by harnessing the human brainpower and creativity of workers and integrating workflows with intelligent systems [16]. This is one of the promising developments, as highlighted by, among others, the European Union agenda indicating that the implementation of cobots is the way forward for sustainable, human-centered industry [19].

Business models for cobots implementation

The choice of business model for implementing cobots, depends on many factors. The decision in this respect depends on the type and scale of the business, as well as the specifics of the individual company and its financial capabilities. Any change in companies involves resources and risks, and should be supported by financial analysis and/or modelling and simulation taking into account various criteria, e.g.: operational efficiency, safety, ergonomics, development opportunities, work organisation and confidence in automation [20].

The decision to purchase machinery, equipment, or technology should be supported by proper analysis, e.g. 'make or buy'. 'Make' means producing in-house, e.g. buying cobots, and 'buy' means buying a service from an external partner (e.g. outsourcing, leasing). When it comes to purchasing cobots that work with employees on workstations, activities should start with defining the strategic goals of the company. This is followed by determining the volumes of demand for products that follow the implementation of processes supported by cobots. Subsequently, a comparative analysis of the company's processes and market offerings are developed and a decision is made to purchase the technology. The enterprise must be aware of the costs of purchasing the cobots and, if applicable, the infrastructure supporting their operation, training employees, and setting up a department to deal with the operation of the new technology within the enterprise, as well as taking the risks associated with the failure of implementation activities [21].

In the case of outsourcing, companies have the opportunity to benefit from global sources of competence, skills, and knowledge. It becomes more important to have access to resources rather than to own them [22]. Building a competitive advantage in the market and developing a company's technology is possible by excluding auxiliary processes from the organizational structure and focusing on core processes [1]. In the case of cobotic technology implementation, the parent company should find a partner with the equipment, technology, and knowledge of services including implementation, employee training, post-implementation care, and maintenance. The type of collaboration chosen can be based on, among other things, an initial, one-off fee, followed by monthly fees, subscription fees, etc.

When an organization offers a unique service, product, or technological process, it is important to properly secure the know-how [23]. In such cases, the concept of in-house outsourcing (IHO) is recommended. IHO is based on the outsourcing of selected parts of the process, e.g. production, which are hermetically sealed within the boundaries of the whole enterprise [24]. The IHO concept is applied, among other things, in a corporate group. It involves the cooperation of two independent entities linked by capital through a parent company [25]. This assumes a situation where the capital group includes a company that has the provision of cobots as part of its services, along with full support for implementation work and post-implementation care [26]. The second option is when the capital group establishes a new company that provides cobot outsourcing services to other companies within the group, as well as to external companies. In this way, the newly created subsidiary gains access to resources and shares in the group's results [27]. The application of the second option should have a positive economic effect, in the form of a faster return on investment.

Value stream mapping

Lean Management (LM) in Industry 4.0 has been present for a long time [28–32], nevertheless, the perspective of Industry 5.0 and the use of cobots seems to be a new idea [33]. Undoubtedly, lean management and Industry 5.0 can complement each other [6,34]. For production processes implemented in a data-rich environment, Industry 5.0 technologies and the solutions offered by lean management must be combined in a common medium of communication. [7,35]. To effectively exploit the benefits offered by lean in industry, an adaptation of one of the most widespread methods, Value Stream Mapping (VSM), is proposed [36,37]. In this configuration, both approaches (LM and Industry 5.0) can be ratified under the common goal of eliminating waste [38,39]. The implementation of VSM enables the implementation of a plan to provide the customer with a product that meets expectations at the lowest possible cost of production and uses the least amount of resource needed to create it. At the same time, it is a space for the use of cobots, which, by replacing human activities in certain processes, will contribute to the optimization of production processes [40]. The overarching goal of LM is to eliminate waste (Japanese: Muda) from processes [38]. The value stream visualizes all activities necessary to produce a product (both value-adding, VA; and non-value-adding, NVA). Thus, the VSM should be seen as a pictorial representation of the product production flow throughout the plant. Assuming that the primary purpose of the VSM is to provide a visualization of process cycle times, inventory buffers, operator deployment, and work and information flows in an area (which aims to capture the entire transformation from raw materials to finished goods), it can be assumed that this technique will be effective for identifying and eliminating waste. To obtain optimal results, it is necessary to focus on operations (jobs) that may represent bottlenecks [41]. In this way, it is possible to obtain a significant amount of data (e.g.: duration of operations, workstation changeover time, types of operations carried out at the workstations, production time per unit of product, number of operators involved in a given operation, production batch size, etc.) that can be used in subsequent stages of production system improvements [42]. A thorough analysis of the collected data and its proper presentation allows the identification of bottlenecks, which may be downtime for machine changeovers, availability of tools, delivery of parts or components, extended time of transport or auxiliary operations, etc. [42]. In the authors' opinion, the identified areas are spaces for the use of cobots.

Lean management distinguishes seven types of waste in a company, among which the authors distinguished five that can be reduced or eliminated by cobots: defects, unnecessary movement, excessive processing, waiting, and unnecessary transport [16,43,44]. Properly configured and trained cobots can support the actions of employees in eliminating the above types of waste through appropriate interactions [45]. The two other types of waste defined by Lean are overproduction and inventory, which can also be eliminated using proper Lean techniques (including: just in time, the right size, and just enough), nevertheless the authors do not find use for cobots here.

COBOTIC SYSTEM DEPLOYMENT MODEL

Concerning the literature research conducted, the possibility of implementing cobots using modern business and management solutions is described. The solution is a set of steps necessary for the implementation of a cobotic system. The process starts with a feasibility analysis, where the technical feasibility of implementing a cobot within the implemented processes (power supply, communication paths, security) is indicated. This is followed by an economic analysis to confirm that the implementation of a cobot makes good business sense. This is followed by the selection of an appropriate deployment model under the economic results. In the next step, an analysis of the production process is carried out to identify locations (operations) where cobots can be used. In the final step, a technical simulation is carried out to confirm the feasibility of cobot deployment (checking assumptions), and a final management decision is taken (Fig. 2).

The issues of feasibility and economic viability analysis depend on the type of company, its machinery, human capital, and investment opportunities. A thorough analysis is required for each enterprise. Therefore, due to the scope of the solution described, the last four steps are described later in this article. In this connection, special attention is given to the issues related to the implementation model, as it depends on the industry and the type of production process being

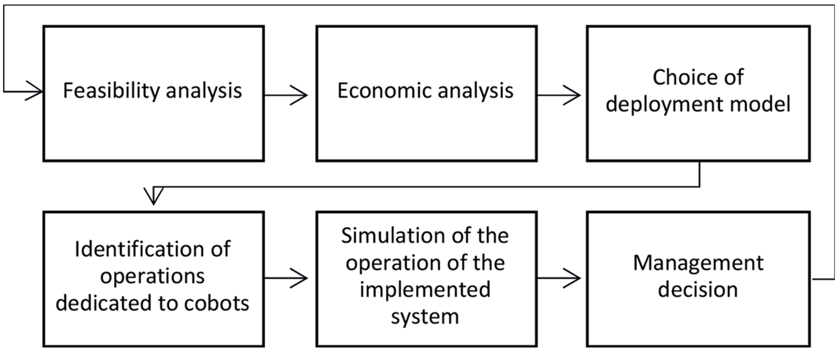


Figure 2. Model for implementing cobots

implemented. Then, according to the literature [15], cobots should be implemented where manual workstations take place to reduce waste. On the other hand, the task of simulation is to confirm or deny the assumptions made. Given the collected data, the last step allows decisions to be taken on implementation, or to refer the solution to the previous step to repeat the procedure.

Concept case

To illustrate the concept presented, a conceptual use case was prepared based on the production process for self-assembly kitchen furniture. Since in the adopted model, production is carried out by a company classified as a large enterprise, outsourcing was selected as the implementation model. The method used to select operations appropriate for cobots was VSM. Simulations were made adequate to the operation times for the machines forming the process described in the literature [5,46]. The finished product realized in the furniture manufacturing process is a package consisting of six sides, accessories, and ground glass (Fig. 3).

The production process begins with the taking of material from the delivery. The materials are supplied as chipboard in standardized sizes, edging in the form of rolls. On the other hand, furniture accessories as well as glazing are supplied by subcontractors.

A key part of the process is the cutting out and preparation of the sides. This process involves several operations. In contrast, single operations are carried out for glazing and accessories. In the process, breakaway fields are located between operations. A critical operation for the process is wrapping and packaging. These operations are carried out by two employees working at one station.

To localise the operations for the implementation of cobotic solutions and to identify possible time savings, the previously described VSM technique was used. Figure 4 shows a furniture production process without cobotic solutions – solely

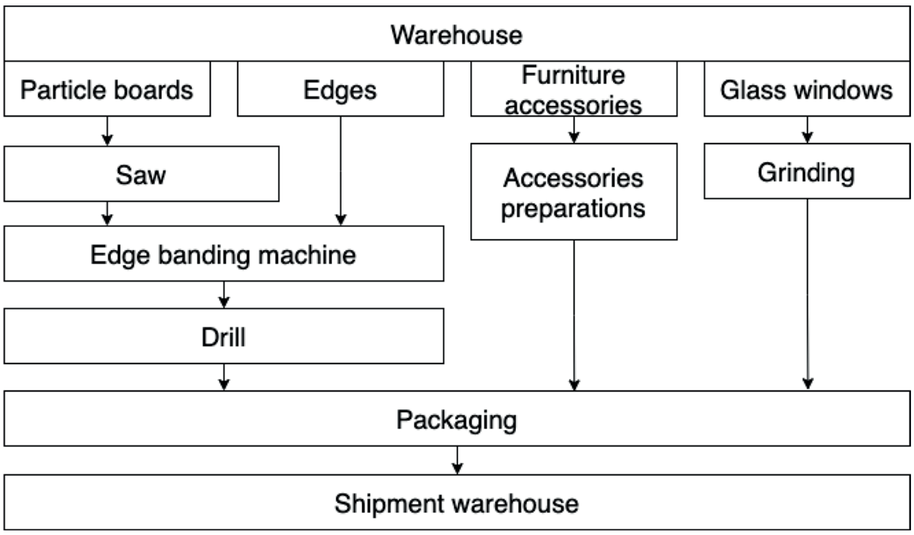


Figure 3. Furniture production process [40]

based on human operators. In this case, all tasks are performed manually.

The timing of the operations carried out at the edge banding machine and packaging is noteworthy. As these are operations that require manual work, it is a fact that they are carried out at individual workstations. For this reason, they can be regarded as critical operations with potential bottlenecks. As such, they have been selected as operations for cobot implementation. The selection of a suitable cobot is dictated by the available space within the shop floor, the scope of the work to be carried out, and the implementation time. It is natural that the use of cobots only makes sense if the technical parameters of the robot exceed the capabilities of the worker. On the other hand, its work also has to be adapted to the worker's pace. Thus, taking into account the constraints that characterize workers (including social, physiological, psychological, etc.), longer preparation and completion times were assumed for them than for cobots for the operations carried out. It was assumed, regarding the literature [5], that the difference is 90 seconds (60 seconds at the start and 30 at the end of the task). In line with the assumed concept case, the time associated with the installation of the cobot in the process was not included in the VSM. Figure 5 shows a value stream map of the cobot-enabled furniture manufacturing process for the two jobs mentioned.

After calculating the time (sum of VA times) for the added value, the expected change in cobot deployment allows a 4.76% (180s) reduction in time. Percentage change in production batch lead time (Eq. 1):

$$Change\,[\%] = \\ = \frac{3780s\,(VA) - 3600s\,(VA)}{3780s\,(VA)} x100\% = 4{,}76\% \quad (1)$$

In addition, the flow of information has been improved through the use of the cobot. Telecommunications solutions allow the cobot to plan and manage its work efficiently. Having identified sites for cobot use and time savings, a simulation using dedicated Enterprise Dynamics simulation software was realized in the next step (Figure 6).

The simulation was designed according to the described furniture production process (Figure 3). The source atoms (Source) of the simulations represent the tasks of taking materials from the warehouse. The processing atoms (Server) were used to represent the machines and equipment that make up the process. An atom (Assembler) was used to simulate the work of the edge banding machine and the packaging station. An output atom (Sink) was used as the transfer storage. It should be noted that the process described here was supplemented by the queue atom (Queue) which serves as a buffer for the production in progress.

The event parameters for individual atoms were calculated and defined as operation times based on the cited sources [5, 46]. The simulation of these times, on the other hand, was realized based on a negative exponential probability distribution. This is a distribution typical of simulations of events occurring continuously and independently with a constant average rate (expressed in 4DS by the function NegExp([seconds]) [47]. For example, for the saw, the simulated operation times were expressed as NegExp(240) (for the other atoms: accessories preparations 600 s, grinding 1800 s, edge banding machine 360 s, drill 60 s, packaging 300 s).

Simulation studies were carried out in two variants: task execution by a two-person human-human team and task execution by a human-cobot collaborative team (Figure 7). The operating parameters of the operator atoms were determined from the literature [28, 46] for both workers and cobots (TeamEmployee), as illustrated in Figure 4 and Figure 5. Five working shifts starting on consecutive days were then simulated in a simulation experiment. Each shift lasted 8 hours without interruption. Production was initiated at the start of the shift by taking materials and finished production status of zero pieces.

RESULTS

As a result of the simulations carried out for each shift, quantities were obtained expressed in pieces of work in progress (semi-finished products) for the atom edge banding machine and packaging input and output, as well as pieces of finished products delivered to the atom shipment warehouse. The results obtained for the human-human variants are presented in Figure 8, and the human-cobot variant in Figure 9.

Using the data from the five shifts, arithmetic means, standard deviations, confidence intervals, and input and output minimum and maximum values were calculated for the quantities of work in progress and finished products respectively for

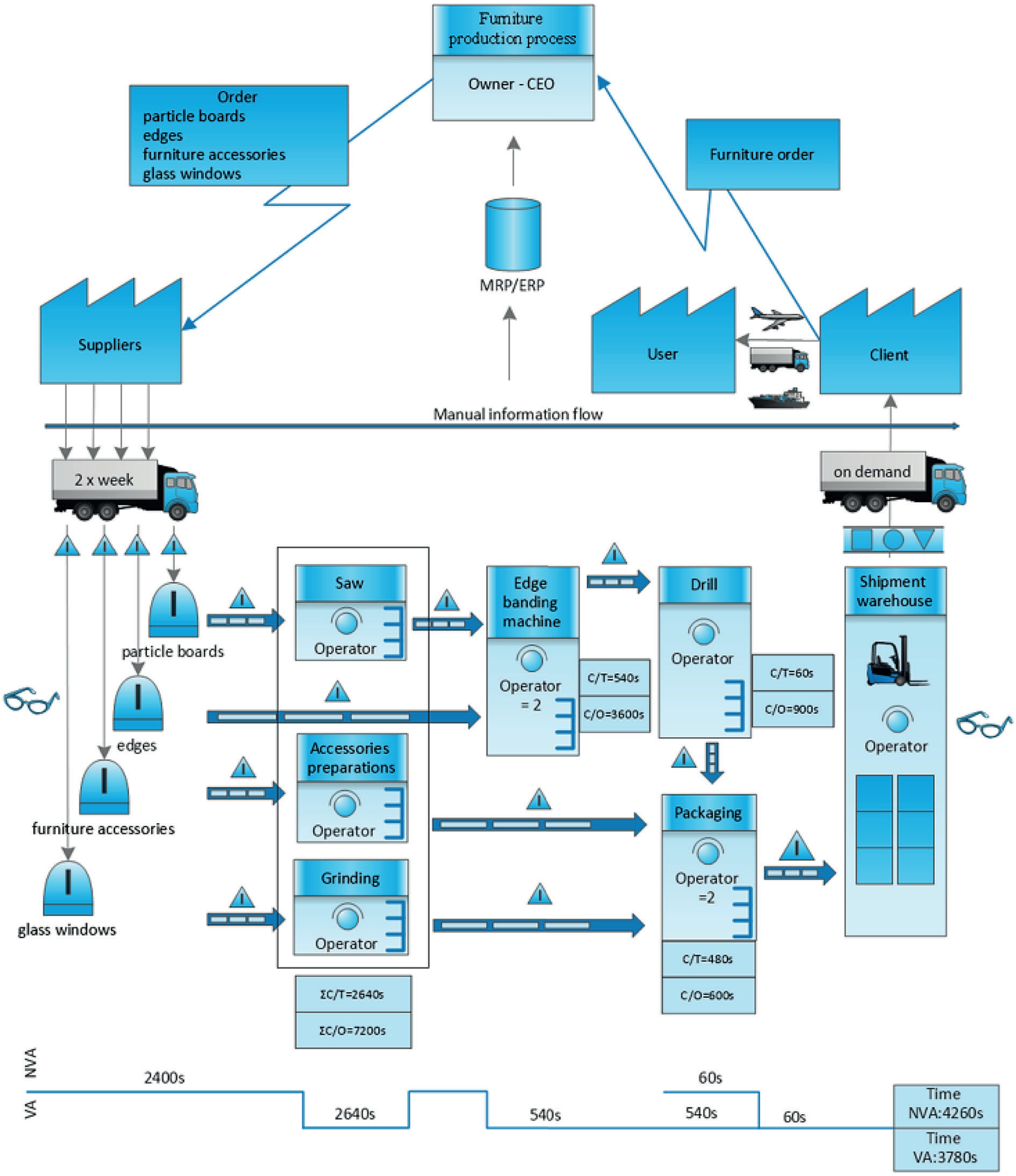


Figure 4. Value stream map of the furniture production process – initial state

the edge banding machine, packaging, and shipment warehouse atoms (Fig. 10 and Fig. 11).

The compared result values for both variants (human-human; human-cobot indicate that for the human-cobot variant, higher averages were obtained for the number of pieces of semi-finished and finished products. For the human-cobot variant, the average number of finished products going to the atom shipment warehouse increased by nearly 35.5% (2.2 pieces of product) compared to the human-human variant (Eq. 2, Eq. 3):

- Output change in pieces

$$Output\ change\ [pieces] = \\ = Atom_{variant_{human-human}} - Atom_{variant_{human-cobot}} \quad (2)$$

- Output change in percentages:

$$Output\ change\ [\%] = \\ \frac{(Atom_{variant_{human-cobot}} - Atom_{variant_{human-human}})}{Atom_{variant_{human-cobot}}}\ x\ 100\% \quad (3)$$

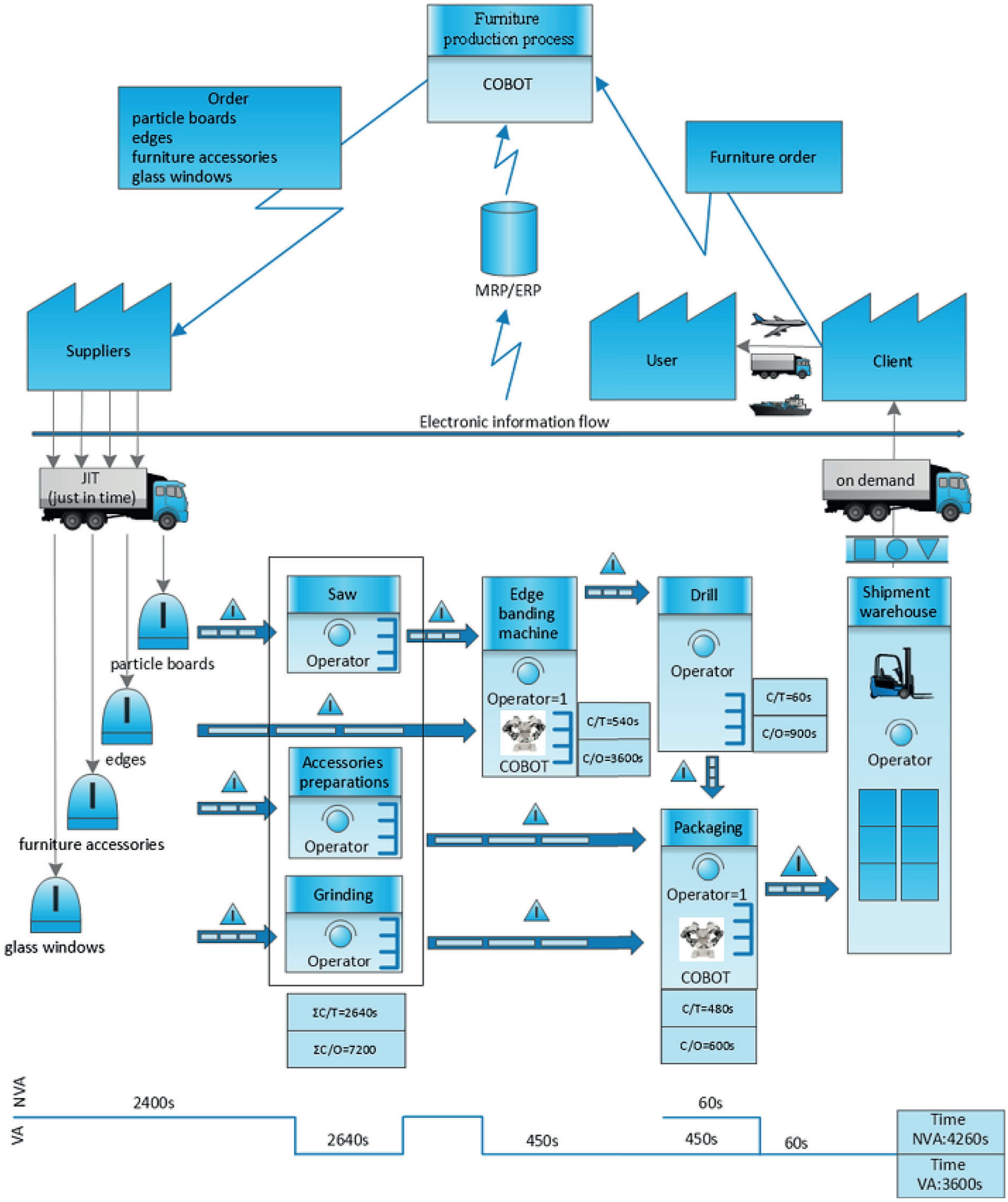


Figure 5. Value stream map of the furniture production process – a cobot perspective

Adequately for the average work-in-progress, the number of semi-finished output pieces increased by 4% (4.6 semi-finished pieces) for the atom edge banding machine and by 30% (18.8 semi-finished pieces) for the atom packaging (Eq. 2, Eq. 3).

Obtaining the above results [time savings of 4.76% (see Eq. 1) and an increase of 35.5% in average production volume (see Eq. 3) was possible thanks to the implementation of human-cobot collaboration.

Obtaining the presented results for human-cobot collaboration was possible due to the interaction of human skills, technical intuition, and cobot performance, which confirms the technical and application value of the considered solution.

The results of the simulations and feasibility and economic analyses proposed in model for

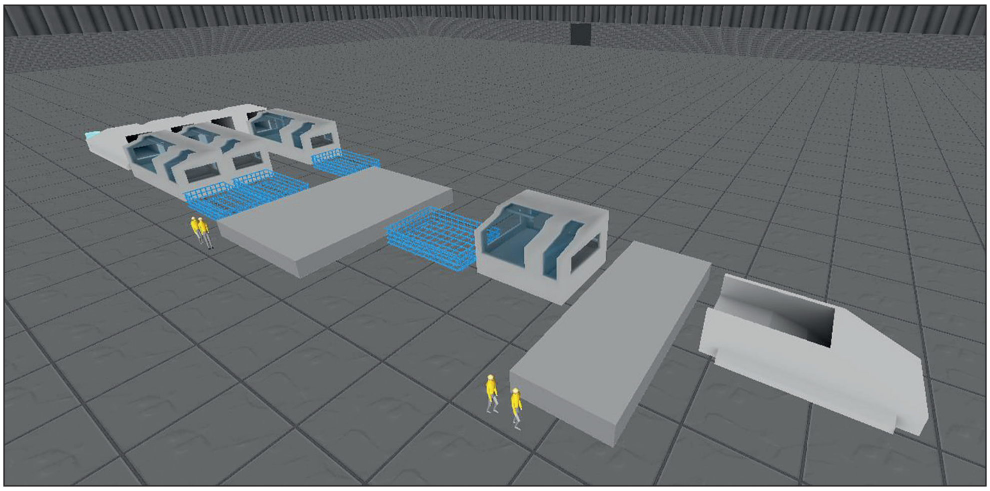


Figure 6. 3D process visualisation

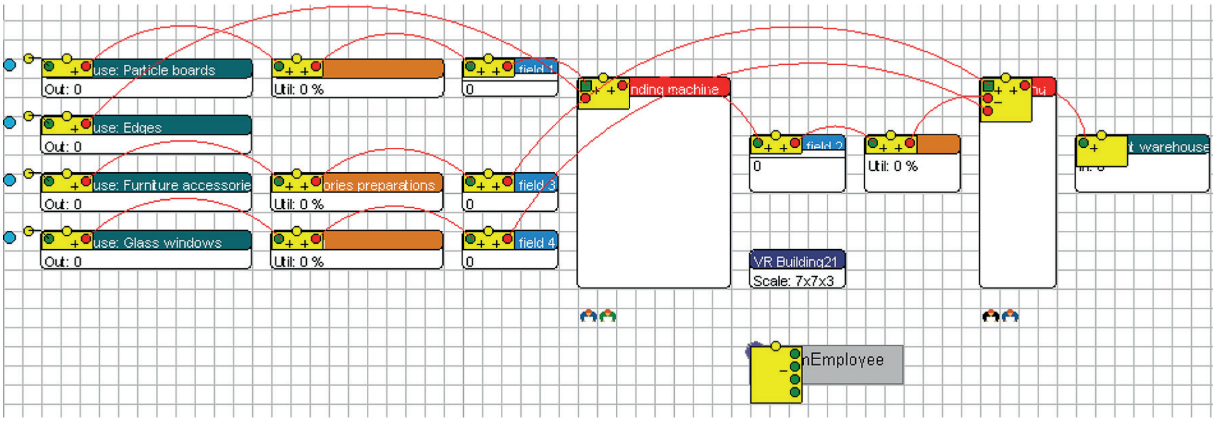
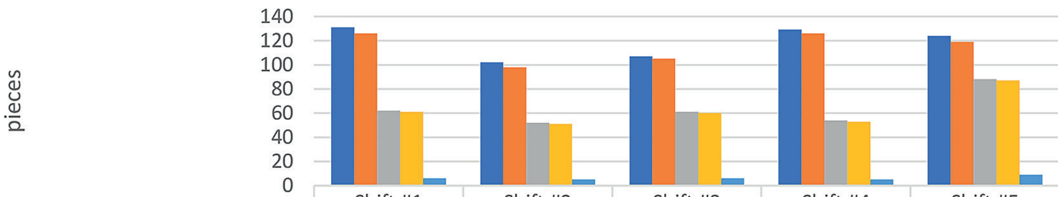


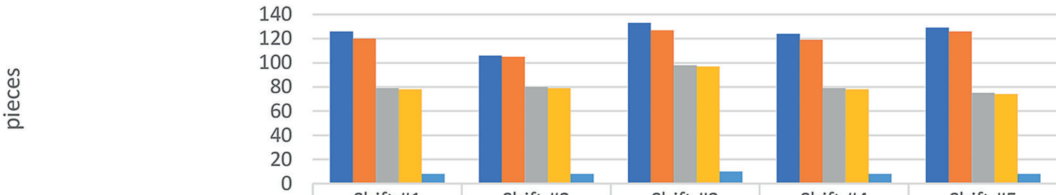
Figure 7. Simulation model



	Shift #1	Shift #2	Shift #3	Shift #4	Shift #5
Edge banding machine Input	131	102	107	129	124
Edge banding machine Output	126	98	105	126	119
Packaging Input	62	52	61	54	88
Packaging Output	61	51	60	53	87
Shipment warehouse Input	6	5	6	5	9

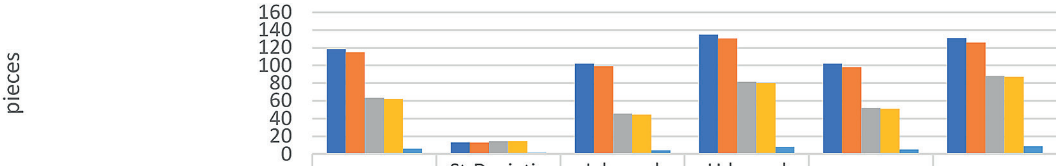
Figure 8. Input and output quantities of finished and semi-finished products for edge banding machine, packaging, and shipment warehouse for each of the five eight-hour shifts in the human-human variant, N=1827 pieces

implementing cobots (Fig. 2) provide the basis for a strategic management decision to implement or not to implement the cobotic system solution. The economic value is understood to be a reduction in the production process time at cobot-enabled workstations, as well as lower scrap rates. The reduction in working time will translate directly into increased production and indirectly into annual revenues. The scale of production is important for the implementation of cobotic solutions. The above measures open up the prospect of the company's growth in terms of improving product quality and attracting new, permanent customers.



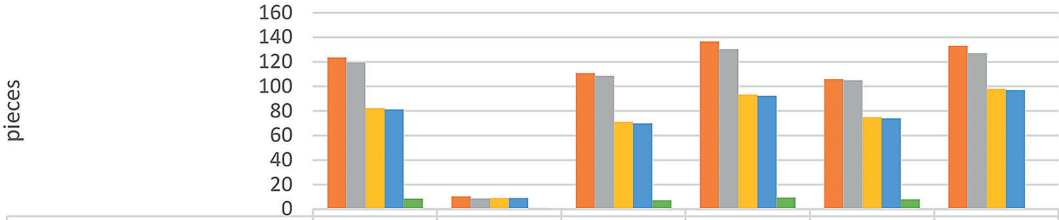
	Shift #1	Shift #2	Shift #3	Shift #4	Shift #5
Edge banding machine Input	126	106	133	124	129
Edge banding machine Output	120	105	127	119	126
Packaging Input	79	80	98	79	75
Packaging Output	78	79	97	78	74
Shipment warehouse Input	8	8	10	8	8

Figure 9. Input and output quantities of finished and semi-finished products for edge banding machine, packaging, and shipment warehouse for each of the five eight-hour shifts in the human-cobot variant, N=2047 pieces



	Average	St.Deviation	L-bound (95%)	U-bound (95%)	Minimum	Maximum
Edge banding machine Input	118,6	13,24	102,16	135,04	102	131
Edge banding machine Output	114,8	12,72	99,01	130,59	98	126
Packaging Input	63,4	14,42	45,5	81,3	52	88
Packaging Output	62,4	14,42	44,5	80,3	51	87
Shipment warehouse Input	6,2	1,64	4,16	8,24	5	9

Figure 10. Results of statistics for the number of pieces of finished and semi-finished products at input and output for edge banding machine, packaging, and shipment warehouse for five eight-hour shifts in the human-human variant total N=1827 pieces



Edge banding machine Input	123,6	10,41	110,68	136,52	106	133
Edge banding machine Output	119,4	8,79	108,48	130,32	105	127
Packaging Input	82,2	9,04	70,97	93,43	75	98
Packaging Output	81,2	9,04	69,97	92,43	74	97
Shipment warehouse Input	8,4	0,89	7,29	9,51	8	0

Figure 11. Results of statistics for the number of pieces of finished and semi-finished products at the input and output for the edge banding machine, packaging, and shipment warehouse for each of the five eight-hour shifts in the human-cobot variant combined N=2047 pieces

DISCUSSION

Given the novelty of cobotic systems technology and lean management techniques well-established in the literature and practice, as well as commonly used business models using different types of services to implement modern organizational solutions (including outsourcing, internal outsourcing within a holding company or purchasing), the presented proposal represents a promising direction for modern enterprises. It also fills the research gap that exists in the case of the desire, and often the necessity, to apply new technologies in the face of limited resources (including financial, infrastructural, and competence) or the prototyping or verification of innovative technologies.

This is an opportunity, especially for large companies that form capital groups. For example, one of the holding companies, acting as a lean management-oriented manufacturing enterprise, decides to expand its workplaces. The expansion may involve the implementation of robots cooperating (cobots) with humans in key processes for the company. By acting strategically, the corporate group will not only enable the use of one company within the group but will also ensure that knowledge and know-how are retained within the entire organizational structure [25]. Furthermore, the provision of outsourcing to one of the subsidiaries can also take place outside the framework of the entire organization, which will affect the effective return on investment. Moreover, this opens up the prospect for the creation of new, highly specialized companies implementing cobotic systems solutions. This direction seems promising and opens up new income opportunities.

Using lean management techniques, waste of time, products, and resources is eliminated, waste is reduced, etc. [48]. The cobot supports the human where it is needed. This is especially true when carrying out routine, forceful or dangerous work [49]. This eliminates potential bottlenecks that manual workstations usually become. The use of lean management techniques in combination with advanced simulation is widely used in business practice, as confirmed by various scientific publications [50]. However, lean management in combination with a service concept (outsourcing) for the use of cobots seems to be a new solution. Furthermore, the use of cobots for reducing machine changeover times at the workstation seems to be an interesting issue. The use of the Single Minute Exchange of Die (SMED) technique as part of lean management and the intelligence of cobots can support the aforementioned processes [51] and be complementary to the concept described in this article by the authors. The challenge will be to teach the cobot to make decisions on the timing and type of changeover. Dividing into different stages and assigning tasks to the human-cobot team [Stage 0 – noting all changeover operations (cobot learning), Stage 1 – dividing activities into external, internal, and unnecessary (human), Stage 2 – changing external activities into internal activities (human-cobot), Stage 3 – improving changeovers (cobot)] will simplify this challenge. This opens the perspective for further research.

The concept case presented here does not answer all the questions or concerns that arise. Moreover, due to the fact of the interdisciplinary combination of managerial and technical issues, it can serve as a inspiration for managers in the implementation of Industry 5.0 solutions in combination with modern business organization and project management techniques.

It should be emphasized that the concept proposed by the authors requires further research to analyze in detail the costs and choice of methods for implementing cobotic solutions from the perspective of large-scale production.

The limitations of the study also include the working times assumed in the literature for the cobots and the physical operators at the positions indicated, as well as the adoption of the ideal case of kitchen furniture production. For example, the question of the speed of the cobot is strictly dependent on safety issues as well as its type. Therefore, it would be interesting to analyze the case study in practice and develop a universal model for implementing the proposed solution as well as a business model for the organization. Despite the indicated limitations, the simulations carried out as part of the concept case seem promising and may inspire further research and attempts at business implementation.

CONCLUSIONS

The perspective formulated is a logical combination of the possibilities provided by the modern technology of Industry 5.0 and modern organizational and management techniques. This opens the perspective for many questions on how to implement a cobotic systems solution in an organization. This is particularly relevant from the perspective of a specific company operating in a specific industry, using selected technologies and work organization methods. The implementation of cobotic solutions should be tailored to the organization's ecosystem. A change in the organization's business strategy involving the implementation of Industry 5.0 solutions, adaptation of a holding organization or, finally, lean management techniques, should fit in with both its sustainable development (CSR, Corporate Social Responsibility) and even ESG (Environmental, Social, Governance) and be economically justified.

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