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Pneumatic Start Gate Technology Transfer and Coach Empowerment in the FF Reborn Malang Push Bike Community

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Abstract: This community service program aims to equip the FF Reborn Malang push bike community, which provides coaching for approximately 50 children aged 4–6 years, with a pneumatic starting gate and to enhance coaches' capacity to operate the equipment independently. Before the intervention, race starts relied on verbal commands and a manually operated iron gate. The gate panels frequently descended unevenly, creating a risk of front wheels becoming trapped beneath partially lowered panels. Race times were also recorded using handheld stopwatches. The program adopted a technology transfer model comprising four stages: gate design and installation, coach empowerment and technology transfer, psychological and pedagogical assistance, and field simulation during a Family Internal Race. Data were collected through functional testing of the device, observations of coaches' operational skills and children's responses, and interviews with the community partner. The data were analyzed descriptively. The pneumatic gate met all functional testing criteria and was formally handed over to the partner along with a memorandum of understanding and a copyright-registered operating manual. All three coaches successfully installed and operated the gate during the race. A total of 50 children participated, exceeding the initial target of 30. Of these, 47 (94%) adapted to the new starting system without displaying signs of anxiety. No incidents of wheels becoming trapped or riders falling occurred at the starting line. Following the handover, the partner continued using the gate for monthly time trials. These findings suggest that introducing a portable pneumatic starting gate alongside coach training and gradual familiarization can enable simultaneous and precisely timed starts in early childhood push bike communities.

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Introduction

Physical activity in the early years supports children's health and development. The World Health Organization recommends that children aged 3–4 years spend at least 180 minutes a day in varied physical activity, part of it at moderate to vigorous intensity (World Health Organization, 2019). Motor skill and physical activity programs for preschoolers have also been linked to gains in cognitive and academic skills, although the evidence is still limited by study quality (Jylänki et al., 2022). The push bike, or balance bike, is a pedal-less

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bicycle that children propel with their feet, and it has become a popular way to get young children moving. Children who start on a balance bike learn to ride independently earlier than children who start with training wheels (Blommenstein & van der Kamp, 2022; Mercê et al., 2022), and balance bike activity improves balance, agility, and leg strength more than tricycles or pedal bicycles do (Yulianti et al., 2024). Structured push bike games have likewise improved the balance of kindergarten students (Pramono et al., 2023), in line with evidence that movement games stimulate gross motor skills in early childhood (Sam et al., 2021).

In BMX, which also uses a start gate, a rider's position after the start is closely related to the finishing position (Rylands & Roberts, 2014), and a faster passage through the first section predicts a better race time (Daneshfar et al., 2020). Gate start performance can be improved through practice with measured feedback (Zabala et al., 2009), and choice reaction time can be trained and tracked systematically (Teteris et al., 2025). Such practice requires every rider to receive the same stimulus at the same moment in every start, and it requires the result to be measured. Without a precise start device, coaches have no objective basis for judging a child's reaction, push-off, or start posture.

Performance anxiety is common among young athletes and can affect both their performance and their well-being (Beenen et al., 2025). Child athletes report a range of stressors in competitive sport (Gómez et al., 2021), and poorly managed sport experiences can affect children's mental health (Xu et al., 2025). Among BMX athletes, the starting gate position is associated with different levels of perceived anxiety (Nuraini et al., 2025). A child who has only heard voice commands may be startled the first time a pneumatic gate releases its air and drops at an official race.

The FF Reborn Malang community coaches about 50 push bike riders aged 4–6 years at the GKB D6 indoor field of Universitas Negeri Malang and in the parking areas of Dinoyo Mall and Malang Town Square. It has three coaches, or roughly one coach for every 17 riders. Discussions with the management and coaches identified four problems. Starts were given by voice command or with an improvised iron gate operated by hand, and the panels rarely dropped together. When a panel did not drop fully, it could catch a front wheel; the coaches estimated that three to five children had caught a wheel on the manual gate during training before the program. Race times were taken with a handheld stopwatch, which made them dependent on the official's reaction time, and they were not stored. The coaches also had no written procedure for operating, maintaining, or troubleshooting an automatic gate, nor any plan for getting children used to one.

Powered start gates already exist in BMX, but they are large, permanently installed, and do not record a rider's time to the finish line. To the team's knowledge, no portable start gate designed for push bike racing is produced in Indonesia. Earlier work by members of the team on microcontroller-based control and motion detection for teaching and health applications (Hidayat et al., 2024; Zaeni et al., 2023), control methods for power electronics (Dewi et al., 2024), and kinematic models of rotating mechanisms (Wiriasto et al., 2025) provided the technical basis for developing one locally. Under Indonesian regulations, appropriate technology (teknologi tepat guna) is technology that meets a community's needs, answers its problems, does not damage the environment, is easy for the community to use and maintain, and adds economic and environmental value (Kementerian Dalam Negeri Republik Indonesia, 2010). Del-Río-Carazo et al. (2021) add that a technology is appropriate when the community that benefits from it can control it. A portable pneumatic start gate fits both descriptions for this partner. It addresses the problems the coaches raised, namely uneven

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starts, panels that catch small wheels, and manual timing. It cost about IDR 15 million to build from materials and standard components sold in local markets, which means a local metal workshop can repair or reproduce it. The modules fold and two people can carry each one, an important point for a community that trains in shared spaces such as parking areas, and the control unit runs on a battery. Operating the gate takes one person pressing one button, and the coaches learned to run it in short workshops with a printed manual.

This program therefore transferred a pneumatic start gate to the partner, together with coach training and gradual familiarization for the children. The proposal set three quantitative targets: one start gate that passes 100% of its function test and comes with an operating manual, one simulated race with at least 30 young riders after gradual familiarization, and three coaches able to operate the gate independently. Although the proposal planned a five-lane gate, the team expanded it to ten lanes made of five dual-lane modules so that one start can hold up to ten children. The following sections describe how the program was carried out and compare its results with these targets.

Method

This program adopted a technology transfer model, in which a technology developed at a university is handed over to a community partner together with the knowledge and skills needed to operate and maintain it. Santoso et al. (2026) used a similar model to build a community group's capacity to run appropriate technology, and Del-Río-Carazo et al. (2021) note that transfer works only when the users take ownership of the technology. In this program, design and installation prepared the technology, the coach workshops transferred the knowledge, psychological and pedagogical assistance supported adoption, and the field simulation applied the technology under real conditions (Figure 1).

The partner was the FF Reborn Malang community, with its three coaches, managers, riders aged 4–6 years, and their parents as participants. The gate was built and tested at Universitas Negeri Malang and the community's training venues during 2026. The field application took place on 16 August 2026 at the Indogrosir parking area in Sukun, Malang, and involved 50 riders aged 4–6 years together with their parents or guardians. The program followed four consecutive stages (Figure 1).

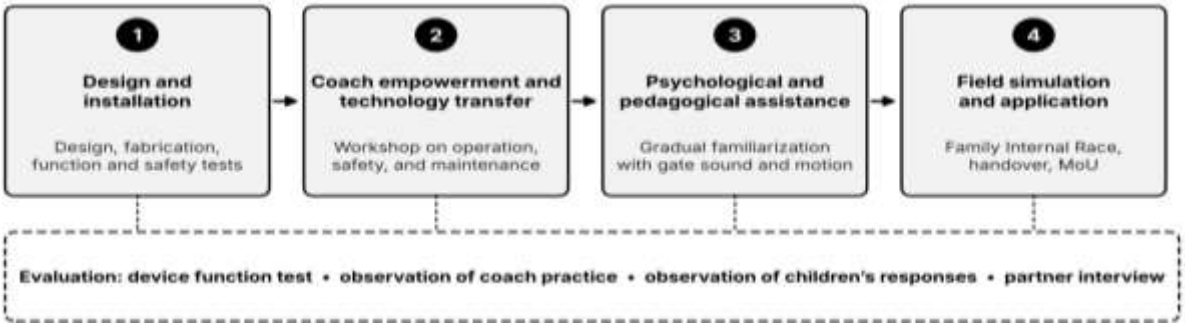


Figure 1. Program Stages and Evaluation

1) **Design and installation**
   The team designed and fabricated the gate, tested its function and safety, and installed it at the partner's venue.
2) **Coach empowerment and technology transfer**
   The three coaches and the managers took part in two workshop sessions before the handover, on 14 and 15 August 2026, and two follow-up sessions after it, on 18 and 19 August 2026. The sessions covered the components, switching the system on and off,

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setting the air pressure, running a start, track safety, maintenance, and simple troubleshooting. They combined explanation with hands-on practice, using the operating manual as the reference.

3) **Psychological and pedagogical assistance**
Coaches and parents were guided to introduce the gate to the children step by step: showing the device, running it without riders, letting children watch from a safe distance, and then practicing in small groups. Children who were not ready were not pushed to start.

4) **Field simulation and application**
The gate was used in a Family Internal Race that served as a simulated official competition. The handover of the device and the signing of a memorandum of understanding (MoU) with the partner took place at the same event.

The partner provided the venue and an electrical outlet for the compressor, assigned its three coaches to the workshop, and arranged for riders and parents to attend the familiarization session and the race. After the handover, the gate became part of the partner's inventory. Parents agreed to the documentation of the activities and the publication of the photographs.

Device performance was evaluated with a function test sheet of seven items: panel simultaneity, flatness of the lowered panel, pressure and leaks, motion speed, electrical system, timer, and emergency operation. Each item was rated as met or not met. Coaches' ability to set up, operate, shut down, and maintain the gate was observed during hands-on practice and at the race against the steps in the manual. Children's responses to the automatic gate, such as readiness at the start line, ability to follow the start signal, and reaction to the gate's sound, were observed during familiarization and at the race. Feedback from the partner was collected through short interviews with the coaches and management. Function test data were analyzed with descriptive statistics, while observation and interview data were analyzed qualitatively. The results were then compared with the three program targets.

Result and Discussion

The Ten-Lane Pneumatic Start Gate

The gate produced in this program has ten lanes formed by five foldable dual-lane modules (Figure 2), twice the five lanes planned in the proposal. The deck surfaces are covered with metal mesh that gives grip to small wheels and feet, and each module folds so that two people can carry it between training venues.



Figure 2. The Ten-Lane Pneumatic Start Gate after Assembly

An operator holds a single button to lower the panels on all lanes together and releases it to raise them (Figure 3). The control unit runs on a battery, so only the compressor needs an electrical outlet. A timer starts when the panels drop and stops when the first rider

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crosses an infrared beam at the finish line, and the time is stored and displayed on a laptop. If air pressure is lost, the panels can still be moved by hand.



Figure 3. Control Unit with Start Button

Function Test Results

The gate was tested with the function test sheet before any child used it, and all seven items met their criteria (Table 1). During testing, the working pressure was set within the 6–7 bar range, and the panel speed was adjusted until the panels dropped quickly without a hard impact at the end of their travel.

Table 1. Function Test Results

Test item	Criterion	Result
Panel simultaneity	Panels on all ten lanes lower and rise together	Met
Flatness of lowered panel	No step that can catch a wheel	Met
Pressure and leaks	Pressure stable at 6–7 bar; no leaks	Met
Motion speed	Panel drops quickly without a hard impact	Met
Electrical system	Ready indicator on; power supply stable	Met
Timer	One time recorded per start and shown on the dashboard	Met
Emergency operation	Panels can be moved by hand without air pressure	Met

Technology Transfer to Coaches and Managers

The three coaches and the managers learned to run the gate through demonstration and hands-on practice, using the operating manual as the reference. The manual covers the component list, assembly, pre-use checks, operation, dismantling, storage, routine maintenance, and troubleshooting. Coach independence was judged by direct observation against the steps in the manual, without a scored checklist or a pre-training test. By the end of the two sessions before the handover, all three coaches (100%) could assemble the gate, carry out the pre-use checks, set the pressure, run starts, and shut the system down in the order given in the manual. On race day, they set up and operated the gate themselves, and the team was present mainly to answer questions. In the two follow-up sessions after the handover, the coaches acted as operators while the procedure was repeated. They have since used the gate in the partner's monthly time trials.

In the interviews, the coaches gave the gate a very positive assessment. Their main suggestion was to add an audible start call, so that pressing the button plays the call and the gate drops automatically when the call ends.

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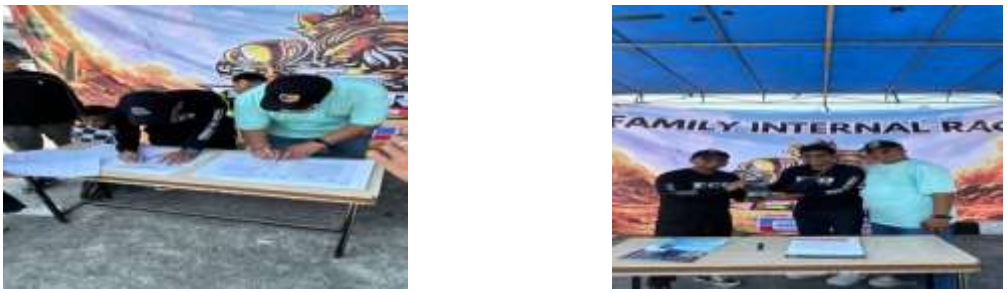
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Familiarization and the Family Internal Race

The children were introduced to the gate in steps. It was first shown to them and their parents and then run without riders, so that the children could hear the air release and watch the panels move from a safe distance. After that, the children practiced in small groups, and the amount of exposure was adjusted to each child's response. Coaches and parents were guided to give simple explanations and positive encouragement.

The Family Internal Race was held on 16 August 2026 at the Indogrosir parking area in Sukun, Malang, with 50 riders aged 4–6 years. At this event the gate was handed over to the partner and the MoU was signed (Figure 4), after which the riders used the gate in heats under race-like conditions (Figure 5). All 50 riders tried the gate and enjoyed it, although they were startled at first. Only three children remained afraid after hearing the air released by the gate. No front wheel caught on a panel and no rider fell at the start line in any heat.



(a) (b)

Figure 4. (a) Signing of the MoU; (b) Handover of the Start Gate to the Partner



(a) (b)

Figure 5. Young Riders Using the Start Gate at the Family Internal Race

Achievement of Program Targets

Table 2 compares the results with the three targets set in the program proposal. All three targets were met, and the target for the simulated race was exceeded.

Table 2. Program Targets and Achievements

Target	Achievement	Status
One start gate passing 100% of its function test, with an operating manual	One ten-lane gate (five lanes planned); 7 of 7 function test items met (100%); operating manual handed over and registered for copyright	Met
One simulated race with at least 30 young riders	Family Internal Race with 50 riders (167% of the target); 47 of 50 riders (94%) adapted without anxiety; no wheel caught or rider fell at the start line	Exceeded
Three coaches able to operate the gate independently	3 of 3 coaches (100%) set up and operated the gate at the race; the coaches have since used it in monthly time trials	Met

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Discussion

Because the panels on all ten lanes move together, every rider is released at the same moment, which a hand-operated gate cannot guarantee. In gated racing, the position after the start largely decides the result (Rylands & Roberts, 2014; Daneshfar et al., 2020), and an uneven start is unfair. It also makes it hard for coaches to judge each child's reaction and push-off. The panel speed is set once and does not change between starts, and each start therefore presents the same stimulus. Under these conditions, the measured-feedback start practice described by Zabala et al. (2009) becomes possible for very young riders. The flat, simultaneous drop of the panels is also consistent with the absence of caught wheels and falls at the start line during the race.

Starting the timer at the moment the gate drops removes the official's reaction time from the measurement. Methodological reviews of sprint testing reach a similar conclusion: electronic timing is more reliable than handheld timing (Haugen & Buchheit, 2016), although results from beam-based systems still depend on which part of the body or bicycle breaks the beam (Bond et al., 2017). Because every time is stored automatically, coaches can follow each child's progress across sessions. During the race, officials no longer needed a stopwatch, since the time of each heat appeared on the dashboard as soon as the first rider crossed the finish line. The current version, however, records only the first rider in each heat.

Gradual familiarization was meant to reduce children's startle response to the sound and motion of the gate. Performance anxiety in young athletes should be recognized and addressed early (Beenen et al., 2025), and coaches and parents need to understand the stressors that child athletes report (Gómez et al., 2021). Children's confidence in their own ability also shapes how they engage with a task (Oktarianto et al., 2024). Although the children were startled at first, almost all of them started without fear after short, repeated exposure, which suggests that gradual familiarization was sufficient for most riders. The three children who remained afraid of the air release may need longer exposure or a quieter exhaust. Because gate conditions are associated with athletes' perceived anxiety (Nuraini et al., 2025), regular practice on a gate that behaves like the one used in official races may help children get used to the conditions of an official start.

Continued use of the gate depends on whether the partner can run it without the team. The operating manual is now the partner's standard operating procedure. It is registered for copyright (registration number 001567030), and the gate is the subject of a simple patent application (number S00202612346) that is under examination. These registrations fix a reference version of the procedure and the design, which keeps the procedure the same when coaches change and allows the patent holders to license the design to other communities. The coaches also hold a time trial at the end of every month to evaluate training progress. This schedule keeps the gate in regular use and builds a stored record of the children's start-to-finish times. The coaches' request for an audible start call has not yet been implemented; the team plans to submit a proposal for internal or external funding to develop the feature and then test it with the coaches. Workshops have been shown to build participants' competence in community service programs (Kusumaningrum et al., 2024), and the three coaches trained in this program now operate the gate. They can contact the Universitas Negeri Malang team directly through the technician's number printed on the device and in the manual.

This program has several limitations. The timer records only the first rider in each heat, and per-lane timing is needed before the system can rank every rider in a heat. Coach independence was observed only after training, without a pre-test or a scored checklist. The drop timing of the old manual gate was never measured either, so the comparison with the

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previous condition relies on coach reports. Children's responses were observed descriptively, not with a standardized instrument, and only at a single event. Measuring each child's reaction time at the gate would also allow more specific start training (Teteris et al., 2025).

Conclusion

The program transferred a ten-lane pneumatic start gate to the FF Reborn Malang community and met all three of its targets. The gate passed every function test item and was handed over with an MoU and an operating manual registered for copyright. At the Family Internal Race, the three coaches set up and ran the gate themselves. Fifty riders took part, above the target of 30, and 47 of them (94%) adapted without anxiety, with no caught wheels or falls at the start line. With foldable modules and a battery-powered control unit, the gate suits a community that trains at changing locations, and its automatic timer removes the official's reaction time from the record. Since the handover, the partner has used the gate for monthly time trials.

Recommendation

For the partner (FF Reborn Malang), the gate should be used in routine training as well as in the monthly time trials, and the monthly times should be kept as a record of each child's progress. The maintenance schedule in the manual should be followed after every session, new coaches should be trained by the three coaches who took part in this program with the manual as the standard procedure, and gradual familiarization should continue for new and younger riders. For policy and replication, local sports offices and push bike associations could use portable gates of this kind to give community clubs the same start conditions as official races. One unit costs about IDR 15 million and is built from locally available materials, so clubs, kindergartens, and regional event organizers could acquire it through local funding or sponsorship, with production licensed by the patent holders. The registered manual can also be adopted as a ready-made standard operating procedure. For developers and future community service teams, the first technical priority is an audible start call that releases the gate automatically when the call ends, as the coaches requested; per-lane timing, a quieter air exhaust, and lighter frames can follow. Methodologically, future programs should measure coaches' procedural accuracy with a scored checklist before and after training, observe children's anxiety with a standardized instrument, and record gate timing on video so that the old and new conditions can be compared.

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