WS-7 Document

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a) Insert all working drawings
b) Also, include BOM's
c) Engineering drawings with all dimensions, tolerances, surface texture information (*)
d) Nasıl tedarik edeceğimizin kararı (make or buy)
e) Üretilecek parçalar için route sheet koyulmalı

Gerisi test planı (hesaplama, analiz, simülasyon gibi)

f) Relating the tests with requirements of our case

1- Clamp force and FoS
2- Buckling of the pipe
3- Gear calculations
4- Speed calculations (Slow motion çekim vb.)
5- Frequency of the ball pitcher (Maltese wheel ile direkt bağlantılı)
6-Bolt seçimi
7-Rulman seçimi

Table 2: Sample test plan table

Requirement	Specification	Description of the test	Equipment needed	AnalIZ Method	AnalIZ result
The system should have adjustable ball translational speed. Maximum ball translational speed needs to be enough to train professional players.	The ball must reach a maximum speed of 30 m/s during launch. It must be adjustable within this range.	Record the moment of launch with a slow motion camera, and scale the distance the ball takes at a certain time to determine the speed of launch.	The equipment required for this test includes a slow motion camera to capture the ball's launch and a board with vertical lines marked at 5 cm intervals to measure the ball's movement.	The test involves recording the ball's launch using the slow motion camera. The board, placed in the ball's trajectory path, helps track the ball's distance over time. By analyzing the video footage, the distance the ball travels within a set time frame (e.g., 1 second) is measured using the 5 cm intervals on the board. The translational speed is then calculated by dividing the distance traveled by the time taken.	The calculated ball speed should match the specified maximum speed of 30 m/s. Additionally, the speed should be adjustable within this range. The result will confirm whether the system is capable of achieving the required ball speed and adjustability for professional training.
The system should have an adjustable throwing frequency. Maximum throwing frequency needs	The ball's launch frequency must provide 60 balls per minute. It must be	The adjustability of the ball-throwing frequency can be tested by configuring the machine at its	The equipment required for this test includes a stopwatch to measure the time	To test the adjustability of the ball-throwing frequency, the machine is configured to its minimum, midpoint, and maximum	The results should confirm that the system can launch 60 balls per minute at the maximum frequency setting and that the frequency is

to be enough to train professional players.	adjustable within this range.	minimum, midpoint, and maximum frequencies. A stopwatch is used to count the balls launched over 60 seconds for each setting, with the test repeated three times to ensure consistency. Smooth and accurate adjustments within the specified range are verified to confirm the system meets performance requirements	and count the number of balls launched, along with the ball-throwing machine configured at different frequency settings.	frequency settings. A stopwatch is used to count the number of balls launched over a 60-second period for each setting. The test is repeated three times for each frequency to ensure consistency and accuracy in the results.	adjustable within this range. The test should verify that the system allows smooth and accurate adjustments, meeting the specified frequency requirements for training professional players.
The system should provide the balls adjustable topspin, backspin, sidespin and and combinations of these spins	The ball must be able to be given spin up to 500 RPM, including backspin, topspin, sidespin, and their derivatives. This spin value must be independent of speed.	The system's ability to provide adjustable topspin, backspin, sidespin, and their combinations can be tested by setting the machine to generate each spin type at various speeds. A tachometer or high-speed camera is used to measure the ball's rotational speed, ensuring spins reach up to 500	The equipment needed for this test includes a tachometer or high-speed camera to measure the ball's rotational speed and the ball-throwing machine configured to generate different spin types at various speeds.	The system's ability to provide adjustable spins is tested by setting the machine to generate different spin types (topspin, backspin, sidespin, and their combinations) at various speeds. The rotational speed of the ball is measured using a tachometer or high-speed camera to ensure the spin reaches up to 500 RPM and remains independent	The results should confirm that the system is capable of generating the required spins (topspin, backspin, sidespin, and combinations) with rotational speeds of up to 500 RPM. The spin should remain independent of the ball's translational speed, verifying that the system meets the spin control requirements accurately and consistently across

		RPM while remaining independent of the ball's velocity. The test is repeated for all spin combinations to confirm accuracy and consistency across configurations.		of the ball's velocity. The test is repeated for all combinations of spins to assess the system's performance.	different spin configurations.
The system should have adjustable positive and negative yaw angle values so that the balls can reach most of the opposite side of the table.	The launcher must provide launch with a yaw angle within a range of ±20 degrees horizontally.	The adjustable yaw angle of the system can be tested by setting the launcher to various yaw angles within the range of ±20 degrees. The ball's landing positions on the opposite side of the table are recorded to verify horizontal coverage. This test is repeated to ensure consistent and accurate performance across the specified range.	The equipment required for this test includes a measuring device to record the ball's landing positions on the opposite side of the table, and a setup that allows the launcher to adjust its yaw angle within the specified range of ±20 degrees.	The test involves adjusting the launcher to various yaw angles within the ±20-degree range. After each adjustment, the ball's landing positions on the opposite side of the table are recorded. This process is repeated multiple times for different angles to verify that the system provides sufficient horizontal coverage across the entire table. The test is designed to check the consistency and accuracy of the yaw angle adjustment.	The results should confirm that the ball lands within the desired areas on the opposite side of the table, verifying that the system provides a yaw angle range of ±20 degrees. The test will also ensure that the system can consistently adjust the yaw angle and achieve accurate performance, meeting the specified requirement for horizontal coverage.
The system should have adjustable negative pitch angle values so that the balls can reach most of the opposite side of the table.	The launcher must provide launch with a pitch angle within a range of 0 to -20 degrees vertically.	The adjustable pitch angle of the system can be tested by setting the launcher to various pitch angles within the	The equipment required for this test includes a measuring device to record the ball's landing positions on	To test the adjustable pitch angle, the launcher is set to various pitch angles within the range of 0 to -20 degrees. After each adjustment, the landing	The results should demonstrate that the system can launch balls with pitch angles within the specified range of 0 to -20 degrees, ensuring vertical

		specified range of 0 to -20 degrees. The ball's landing positions on the opposite side of the table are recorded to verify vertical coverage. This test should be performed at multiple pitch angles within the range to ensure that the system consistently provides the expected launch angles. The results should be analyzed to confirm that the balls reach most of the opposite side of the table, as specified. The test should be repeated to ensure accuracy and consistency across the range of pitch angles.	the opposite side of the table and a launcher with adjustable pitch angle settings.	positions of the balls on the opposite side of the table are recorded. The test is performed at multiple pitch angles to ensure that the system provides consistent and accurate vertical coverage. The results are then analyzed to confirm that the balls land in most areas of the opposite side of the table.	coverage across the table. The test will verify that the system consistently provides accurate launch angles, meeting the requirement for adjustable pitch angles and proper vertical distribution of the ball's landing positions.
Ball storage must satisfy sufficient stored ball count so that an uninterrupted ball supply is provided.	There should be 60 balls in the storage.	A box (made of cardboard etc) is made to ensure that the storage has enough capacity.	The equipment needed for this test includes a box (made of cardboard or other suitable materials) to hold	To test the ball storage capacity, the box is filled with 60 balls to ensure it can hold the required number. The storage system is then evaluated	The results should confirm that the storage box can hold exactly 60 balls, meeting the requirement for sufficient stored ball count. This test will verify that the

			the balls and a set of 60 balls to verify storage capacity.	to confirm that it accommodates all 60 balls without any issues, ensuring uninterrupted supply during operation.e is enough.	system is capable of providing an uninterrupted ball supply with the specified capacity.
The maximum weight of the system components that are to be carried separately before assembly at the table should comply with ISO-FDIS-11228 ergonomics standards.	The maximum weight of the entire system must not exceed 25 kilograms.	The maximum weight of the system components can be tested by individually weighing each part before assembly using a calibrated digital scale. Each component's weight should be compared to the specified limits according to the ISO-FDIS-11228 ergonomics standards. Additionally, the weight of the entire assembled system should be measured, ensuring it does not exceed the 25-kilogram limit. This test should be repeated to verify consistent results and ensure the system	The equipment required for this test includes a calibrated digital scale to measure the weight of each system component individually before assembly, as well as the scale to weigh the entire assembled system.	The test involves weighing each individual component of the system using the calibrated digital scale before assembly. The weight of each component is compared to the limits specified by the ISO-FDIS-11228 ergonomics standards. Once the system is fully assembled, the total weight is measured to ensure it does not exceed the 25-kilogram limit. This process is repeated to verify consistency and confirm that all weight limits are adhered to.	The results should confirm that each component's weight is within the prescribed limits according to ISO-FDIS-11228 standards, and that the total weight of the assembled system does not exceed 25 kilograms. This test ensures that the system complies with ergonomic weight requirements for ease of handling and transport.

		complies with the weight restriction.			
The system should be mounted to the ITTF standard table extremity at the center rigidly.	The system is securely fastened to the table or floor in the middle of the opponent's side of the ITTF standard table, at the center of the width of the table. The maximum displacement after 50 throws shall be 20 mm	The system's mounting position can be tested by securely fastening it to the ITTF standard table at the center of the opponent's side, ensuring it is rigidly mounted according to the specified location. After mounting, the system should be operated, launching 50 balls in succession. The displacement of the system from its original position is measured after the 50 throws using a precision displacement sensor or measuring tools. The displacement should not exceed 20 mm. This test should be repeated to verify the system's stability and adherence to the specified displacement limit.	A measurement device to measure the displacement of the device. This measurement provides the necessary deviation information.		

The system should damage neither the table nor the tennis ball during operation.	The lifetime of a single ball in the cycle should be at least 1000 throws.	The system's impact on both the table and the tennis ball can be tested by conducting a series of throws using the machine. Each ball should be launched at various speeds and angles to ensure that the table and ball are not damaged. After a set of 1000 throws, the condition of the ball should be inspected for any signs of wear or damage, such as cracks or deformation. The table surface should also be checked for any scratches, dents, or other damages. This test should be repeated multiple times with different balls to ensure that the system consistently meets the requirement of not damaging either the table or the ball during operation.	The equipment needed for this test includes a set of tennis balls, the ball-launching system, and inspection tools such as a magnifying glass or microscope to check for damage on the balls and a visual inspection for any damage to the table surface.	The test involves launching the balls at various speeds and angles using the system to simulate normal operation. After 1000 throws, each ball is inspected for signs of wear, such as cracks or deformation. The table's surface is also examined for any damage, including scratches or dents. The test is repeated multiple times using different balls to ensure consistency and to verify that the system does not cause any damage to the table or balls during operation.	The results should confirm that the balls exhibit no signs of wear or damage after at least 1000 throws and that the table surface remains undamaged, with no visible scratches or dents. This test ensures that the system meets the requirement of not damaging either the table or the tennis balls during its operation.

The system should have a user interface where users can input ball throw parameters such as impact location, speed, spin, etc.	The system must have a user interface allowing launch parameter configuration with a maximum 10% deviation.	The user interface can be tested by inputting various ball throw parameters such as impact location, speed, and spin into the system. The entered values should be compared with the actual launch parameters of the system to verify that the system allows for configuration with a maximum deviation of 10%. This test should be repeated for multiple sets of parameters to ensure consistency and accuracy of the user interface. The ball's actual launch speed, spin, and impact location should be measured using appropriate sensors, and the deviations from the input parameters should not exceed the 10% limit. The test should ensure the system	The equipment required for this test includes the user interface of the system, sensors to measure the ball's launch speed, spin, and impact location, and a system for comparing the entered input parameters to the actual launch parameters.	The test involves inputting various ball throw parameters, such as impact location, speed, and spin, into the system's user interface. The ball's actual launch speed, spin, and impact location are then measured using the appropriate sensors. The entered values are compared to the actual results to determine if the deviation between the input and output parameters exceeds the maximum allowed limit of 10%. This process is repeated for multiple sets of parameters to ensure the system consistently meets the deviation requirement.	The results should confirm that the system's actual launch parameters do not deviate by more than 10% from the input parameters. The test will verify that the user interface is accurate and responsive, meeting the requirement for configurable launch parameters within the specified deviation limit.

		responds accurately to user input and meets the specified deviation requirement.			
The user-struck balls should be stopped from the opposite side of the table with some sort of collector mechanism.	The design can collect the properly returned balls from the player. Recyclable ball height needs to be at least 1 meter.	The collector mechanism can be tested by simulating a scenario where balls are returned by the player from the opposite side of the table. The system should be able to collect all returned balls effectively. The height of the recyclable ball collection area should be measured to ensure it reaches at least 1 meter. This can be tested by returning balls at various speeds and angles and observing if they are properly captured by the collector. The test should be repeated under different conditions to verify the system's ability to	The equipment needed for this test is a 1-meter long net to cover the side, opposite to the player to return the balls properly.		

		consistently collect the balls and ensure the 1-meter height requirement is met.			
The system should be suitable for standard table tennis tables and rules as defined by ITTF.	The system is compliant with ITTF table and ball dimensions: • Suitable for a 2.74 m long and 1.525 m wide table. • Can serve over a 15.25 cm high net. • Suitable for standard table tennis balls with a 2.7-gram weight and 40 mm di-ameter.	The system's compliance with ITTF standards can be tested by placing it on a table that is 2.74 meters long and 1.525 meters wide, ensuring proper fit and functionality. The system should also be tested with a 15.25 cm high net, verifying that the balls clear the net during launch. Additionally, standard 2.7-gram, 40 mm diameter table tennis balls should be used to ensure the system handles and launches them accurately. These tests should confirm that the system meets ITTF table and ball specifications.	The equipment required for this test includes a table with dimensions of 2.74 meters in length and 1.525 meters in width, a 15.25 cm high table tennis net, and standard 2.7-gram, 40 mm diameter table tennis balls.	To test compliance with ITTF standards, the system is placed on a table that is 2.74 meters long and 1.525 meters wide to verify proper fit. The system is then tested with a 15.25 cm high net to ensure that the balls clear the net during launch. Standard table tennis balls with a weight of 2.7 grams and a diameter of 40 mm are used to confirm that the system handles and launches them accurately.	The results should confirm that the system fits properly on the specified table dimensions, launches balls that clear the 15.25 cm high net, and functions correctly with standard table tennis balls. This ensures that the system meets the ITTF specifications for table and ball dimensions and adheres to the standard table tennis rules.

The power consumption of the system should be minimized.	The machine should operate on standard mains electricity (220-240V, 50-60 Hz). Also, it should not consume more than 2000W.	The power consumption of the system can be tested by measuring the electrical usage during operation. The system should be connected to a standard mains electricity supply (220-240V, 50-60 Hz). A power meter should be used to measure the system's total power consumption, ensuring that it does not exceed 2000W. This test should be performed while the system is running under typical operating conditions, and the results should confirm that the power consumption remains within the specified limit.	The equipment required for this test includes a power meter to measure the system's total power consumption, and a standard mains electricity supply (220-240V, 50-60 Hz).	The system is connected to a standard mains electricity supply (220-240V, 50-60 Hz), and a power meter is used to measure its electrical usage during operation. The system is run under typical operating conditions, and the total power consumption is recorded. The measurement is analyzed to ensure that the system's power consumption does not exceed 2000W.	The results should confirm that the system's power consumption remains within the specified limit of 2000W while operating under typical conditions. This test ensures that the system complies with the requirement for minimized power consumption.
The total cost of the system should be kept	Total spending for the prototype of the design should be	The total cost of the system can be tested by tracking all	The equipment required for this test includes a list of all	The total cost of the system is tested by tracking all expenses	The results should confirm that the total spending for the prototype does not

within the assigned budget.	kept within 300 USD.	expenses involved in the design and prototype construction. Each component and material used should be priced, and the total spending for the prototype must be calculated. The final cost should be compared to the assigned budget, ensuring that it does not exceed 300 USD. This test should be repeated to confirm that all costs are accurately accounted for and the total spending remains within the specified budget.	components and materials used in the design, as well as access to pricing information for each item. A calculator or spreadsheet software is necessary to track and calculate the total expenses.	related to the design and prototype construction. Each component and material used in the system is priced, and the total spending for the prototype is calculated. The final cost is then compared to the assigned budget to ensure it does not exceed the 300 USD limit. This process is repeated to verify that all costs are accurately accounted for.	exceed the 300 USD budget. This test ensures that the system is developed within the financial constraints, meeting the cost requirement.
The design should be portable; i.e., one person should be able to transport the unassembled system by themselves.	The design, when unassembled, should fit inside a 1 m3 box.	The portability of the system can be tested by attempting to transport the unassembled components by one person. The system should be able to fit comfortably inside a 1 m^3 box when	The equipment required for this test includes a measuring tape or ruler to measure the dimensions of the unassembled system, a 1 m^3 box, and a person to test	The test involves disassembling the system and measuring its components to ensure they fit comfortably inside a 1 m^3 box. The dimensions of the unassembled system are compared to the box's size to confirm it fits within	The results should confirm that the system, when unassembled, fits inside the 1 m^3 box and can be transported by one person. This test ensures that the design is portable and meets the requirement for easy transportation.

		disassembled. This can be verified by measuring the dimensions of the unassembled system and ensuring it fits within the specified volume. Additionally, the user should be able to carry the box without assistance, confirming that it is lightweight and manageable for one person to transport.	the portability by carrying the box.	the specified volume. Additionally, one person should attempt to transport the box to ensure that it is lightweight and manageable for a single individual.	

Table 2: Sample test plan table

Requirement	Specification	Description of the test	Equipment needed	Analysis Method	Analysis Result
The system should have adjustable ball translational speed. Maximum ball translational speed needs to be enough to train professional players.	The ball must reach a maximum speed of 30 m/s during launch. It must be adjustable within this range.	Record the moment of launch with a slow motion camera and scale the distance the ball takes at a certain time to determine the speed of launch.	The equipment required for this test includes a slow-motion camera to capture the ball's launch and a board with vertical lines marked at 5 cm intervals to measure the ball's movement.	The test involves recording the ball's launch using a slow-motion camera. The board, placed in the ball's trajectory path, helps track the ball's distance over time. By analyzing the video footage, the distance the ball travels within a set time frame (e.g., 1 second) is measured using the 5 cm intervals on the board. The translational speed is then calculated by dividing the distance traveled by the time taken.	The calculated ball speed should match the specified maximum speed of 30 m/s. Additionally, the speed should be adjustable within this range. The result will confirm whether the system is capable of achieving the required ball speed and adjustability for professional training.
The system should have an adjustable throwing frequency. Maximum throwing frequency needs to be enough to train professional players.	The ball's launch frequency must provide 60 balls per minute. It must be adjustable within this range.	The adjustability of the ball-throwing frequency can be tested by configuring the machine at its minimum, midpoint, and maximum frequencies. A stopwatch is used to count the balls launched over 60 seconds for each setting, with the test repeated three times to ensure consistency. Smooth and accurate adjustments within the specified range are verified to confirm the system meets performance requirements	The equipment required for this test includes a stopwatch to measure the time and count the number of balls launched, along with the ball-throwing machine configured at different frequency settings.	To test the adjustability of the ball-throwing frequency, the machine is configured to its minimum, midpoint, and maximum frequency settings. A stopwatch is used to count the number of balls launched over a 60-second period for each setting. The test is repeated three times for each frequency to ensure consistency and accuracy in the results.	The results should confirm that the system can launch 60 balls per minute at the maximum frequency setting and that the frequency is adjustable within this range. The test should verify that the system allows smooth and accurate adjustments, meeting the specified frequency requirements for training professional players.

The system should provide the balls adjustable topspin, backspin, sidespin and and combinations of these spins	The ball must be able to be given spin up to 500 RPM, including backspin, topspin, sidespin, and their derivatives. This spin value must be independent of speed.	The system's ability to provide adjustable topspin, backspin, sidespin, and their combinations can be tested by setting the machine to generate each spin type at various speeds. A tachometer or high-speed camera is used to measure the ball's rotational speed, ensuring spins reach up to 500 RPM while remaining independent of the ball's velocity. The test is repeated for all spin combinations to confirm accuracy and consistency across configurations.	The equipment needed for this test includes a tachometer or high-speed camera to measure the ball's rotational speed and the ball-throwing machine configured to generate different spin types at various speeds.	The system's ability to provide adjustable spins is tested by setting the machine to generate different spin types (topspin, backspin, sidespin, and their combinations) at various speeds. The rotational speed of the ball is measured using a tachometer or high-speed camera to ensure the spin reaches up to 500 RPM and remains independent of the ball's velocity. The test is repeated for all combinations of spins to assess the system's performance.	The results should confirm that the system is capable of generating the required spins (topspin, backspin, sidespin, and combinations) with rotational speeds of up to 500 RPM. The spin should remain independent of the ball's translational speed, verifying that the system meets the spin control requirements accurately and consistently across different spin configurations.
The system should have adjustable positive and negative yaw angle values so that the balls can reach most of the opposite side of the table.	The launcher must provide launch with a yaw angle within a range of ±20 degrees horizontally.	The adjustable yaw angle of the system can be tested by setting the launcher to various yaw angles within the range of ±20 degrees. The ball's landing positions on the opposite side of the table are recorded to verify horizontal coverage. This test is repeated to ensure consistent and accurate performance across the specified range.	The equipment required for this test includes a measuring device to record the ball's landing positions on the opposite side of the table, and a setup that allows the launcher to adjust its yaw angle within the specified range of ±20 degrees	The test involves adjusting the launcher to various yaw angles within the ±20-degree range. After each adjustment, the ball's landing positions on the opposite side of the table are recorded. This process is repeated multiple times for different angles to verify that the system provides sufficient horizontal coverage across the entire table. The test is designed to check the consistency and accuracy of the yaw angle adjustment.	The results should confirm that the ball lands within the desired areas on the opposite side of the table, verifying that the system provides a yaw angle range of ±20 degrees. The test will also ensure that the system can consistently adjust the yaw angle and achieve accurate performance, meeting the specified requirement for horizontal

The system should have adjustable negative pitch angle values so that the balls can reach most of the opposite side of the table.	The launcher must provide launch with a pitch angle within a range of 0 to -20 degrees vertically.	The adjustable pitch angle of the system can be tested by setting the launcher to various pitch angles within the specified range of 0 to -20 degrees. The ball's landing positions on the opposite side of the table are recorded to verify vertical coverage. This test should be performed at multiple pitch angles within the range to ensure that the system consistently provides the expected launch angles. The results should be analyzed to confirm that the balls reach most of the opposite side of the table, as specified. The test should be repeated to ensure accuracy and consistency across the range of pitch angles.	The equipment required for this test includes a measuring device to record the ball's landing positions on the opposite side of the table and a launcher with adjustable pitch angle settings.	To test the adjustable pitch angle, the launcher is set to various pitch angles within the range of 0 to -20 degrees. After each adjustment, the landing positions of the balls on the opposite side of the table are recorded. The test is performed at multiple pitch angles to ensure that the system provides consistent and accurate vertical coverage. The results are then analyzed to confirm that the balls land in most areas on the opposite side of the table.	The results should demonstrate that the system can launch balls with pitch angles within the specified range of 0 to -20 degrees, ensuring vertical coverage across the table. The test will verify that the system consistently provides accurate launch angles, meeting the requirement for adjustable pitch angles and proper vertical distribution of the ball's landing pos
Ball storage must satisfy sufficient stored ball count so that an uninterrupted ball supply is provided.	There should be 60 balls in storage.	A box (made of cardboard etc.) is made to ensure that the storage has enough capacity.	The box, the balls and a measurement device to have information about the dimensions of the storage	The box is filled with the required number of balls, and it is inspected to see if the box volume is enough.	The box has the capacity to carry 70 balls, which is determined by putting 60 balls initially, then the empty volume is filled with more balls.
The maximum weight of the system components that are to be carried separately before assembly at the table should comply with ISO-FDIS-11228 ergonomics standards.	The maximum weight of the entire system must not exceed 25 kilograms.	The maximum weight of the system components can be tested by individually weighing each part before assembly using a calibrated digital scale. Each component's weight should be compared to the specified limits according to the ISO-FDIS-11228 ergonomics standards. Additionally, the weight of the entire assembled system should be measured, ensuring it does not exceed the 25-kilogram limit. This test should be repeated to verify consistent results and ensure the system complies with the weight restriction.	The equipment required for this test includes a calibrated digital scale to measure the weight of each system component individually before assembly, as well as the scale to weigh the entire assembled system	The test involves weighing each individual component of the system using the calibrated digital scale before assembly. The weight of each component is compared to the limits specified by the ISO-FDIS-11228 ergonomics standards. Once the system is fully assembled, the total weight is measured to ensure it does not exceed the 25-kilogram limit. This process is repeated to verify consistency and confirm that all weight limits are adhered to.	The results should confirm that each component's weight is within the prescribed limits according to ISO-FDIS-11228 standards, and that the total weight of the assembled system does not exceed 25 kilograms. This test ensures that the system complies with ergonomic weight requirements for ease of handling and transport.

The system should be mounted to the ITTF standard table extremity at the center rigidly.	The system is securely fastened to the table or floor in the middle of the opponent's side of the ITTF standard table, at the center of the width of the table. The maximum displacement after 50 throws shall be 20 mm	The system's mounting position can be tested by securely fastening it to the ITTF standard table at the center of the opponent's side, ensuring it is rigidly mounted according to the specified location. After mounting, the system should be operated, launching 50 balls in succession. The displacement of the system from its original position is measured after the 50 throws using a precision displacement sensor or measuring tools. The displacement should not exceed 20 mm. This test should be repeated to verify the system's stability and adherence to the specified displacement limit.	The equipment required for this test includes a precision displacement sensor or measuring tools (such as a ruler or caliper), a mounting system, and the ITTF standard table.	The mounting position is tested by securely fastening the system to the ITTF standard table at the center of the opponent's side, ensuring that it is rigidly mounted. After mounting, the system is operated, launching 50 balls in succession. The displacement of the system from its original position is measured using a precision displacement sensor or other measuring tools. The displacement should not exceed 20 mm after 50 throws. This test is repeated to ensure consistent results and verify that the system maintains stability and adheres to the displacement limit.	The results should confirm that the system remains securely mounted, with the displacement not exceeding the 20 mm limit after 50 throws. This ensures that the mounting system is stable and rigid, as specified in the requirement.
The system should damage neither the table nor the tennis ball during operation.	The lifetime of a single ball in the cycle should be at least 1000 throws.	The system's impact on both the table and the tennis ball can be tested by conducting a series of throws using the machine. Each ball should be launched at various speeds and angles to ensure that the table and ball are not damaged. After a set of 1000 throws, the condition of the ball should be inspected for any signs of wear or damage, such as cracks or deformation. The table surface should also be checked for any scratches, dents, or other damage. This test should be repeated multiple times with different balls to ensure that the system consistently meets the requirement of not damaging either the table or the ball during operation.	The equipment needed for this test includes a set of tennis balls, the ball-launching system, and inspection tools such as a magnifying glass or microscope to check for damage on the balls and a visual inspection for any damage to the table surface.	The test involves launching the balls at various speeds and angles using the system to simulate normal operation. After 1000 throws, each ball is inspected for signs of wear, such as cracks or deformation. The table's surface is also examined for any damage, including scratches or dents. The test is repeated multiple times using different balls to ensure consistency and to verify that the system does not cause any damage to the table or balls during operation.	The results should confirm that the balls exhibit no signs of wear or damage after at least 1000 throws and that the table surface remains undamaged, with no visible scratches or dents. This test ensures that the system meets the requirement of not damaging either the table or the tennis balls during its operation.

The system should have a user interface where users can input ball throw parameters such as impact location, speed, spin, etc.	The system must have a user interface allowing launch parameter configuration with a maximum 10% deviation.	The user interface can be tested by inputting various ball throw parameters such as impact location, speed, and spin into the system. The entered values should be compared with the actual launch parameters of the system to verify that the system allows for configuration with a maximum deviation of 10%. This test should be repeated for multiple sets of parameters to ensure consistency and accuracy of the user interface. The ball's actual launch speed, spin, and impact location should be measured using appropriate sensors, and the deviations from the input parameters should not exceed the 10% limit. The test should ensure the system responds accurately to user input and meets the specified deviation requirement.	The equipment required for this test includes the user interface of the system, sensors to measure the ball's launch speed, spin, and impact location, and a system for comparing the entered input parameters to the actual launch parameters.	The test involves inputting various ball throw parameters, such as impact location, speed, and spin, into the system's user interface. The ball's actual launch speed, spin, and impact location are then measured using the appropriate sensors. The entered values are compared to the actual results to determine if the deviation between the input and output parameters exceeds the maximum allowed limit of 10%. This process is repeated for multiple sets of parameters to ensure the system consistently meets the deviation requirement.	The results should confirm that the system's actual launch parameters do not deviate by more than 10% from the input parameters. The test will verify that the user interface is accurate and responsive, meeting the requirement for configurable launch parameters within the specified deviation limit.
The user-struck balls should be stopped from the opposite side of the table with some sort of collector mechanism.	The design can collect the properly returned balls from the player. Recyclable ball height needs to be at least 1 meter.	The collector mechanism can be tested by simulating a scenario where balls are returned by the player from the opposite side of the table. The system should be able to collect all returned balls effectively. The height of the recyclable ball collection area should be measured to ensure it reaches at least 1 meter. This can be tested by returning balls at various speeds and angles and observing if they are properly captured by the collector. The test should be repeated under different conditions to verify the system's ability to consistently collect the balls and ensure the 1-meter height requirement is met.	The equipment required for this test includes a -meter-long net to cover the side opposite the player, and the collector mechanism for capturing the balls.	The collector mechanism is tested by simulating a scenario where balls are returned by the player from the opposite side of the table. The system should effectively collect all returned balls. The height of the recyclable ball collection area is measured to ensure it reaches at least 1 meter. Balls are returned at various speeds and angles, and the performance of the collector is observed to verify that all balls are properly captured. The test is repeated under different conditions to ensure consistency and verify the 1-meter height requirement.	The results should confirm that the system can collect all returned balls efficiently and that the recyclable ball collection area reaches a height of at least 1 meter. This ensures that the design meets the specified requirements for ball collection and height.

The system should be suitable for standard table tennis tables and ules as defined by ITTF.	he system is compliant with ITTF table and ball dimensions: • Suitable for a 2.74 m long and 1.525 m wide table. • Can serve over a 15.25 cm high net. • Suitable for standard able tennis balls with a 2.7-gram weight and 40 mm di- ammeter.	The system's compliance with ITTF tandards can be tested by placing it on a table that is 2.74 meters long and 1.525 meters wide, ensuring proper fit and functionality. The system should also be tested with a 15.25 cm high net, verifying that the balls clear the net during launch. Additionally, standard 2.7-gram, 40 mm diameter table tennis balls should be used to ensure the system handles and launches them accurately. These tests should confirm that the system meets ITTF table and ball specifications.	The equipment required for his test includes a table with limensions of 2.74 meters in length and 1.525 meters in vidth, a 15.25 cm high table tennis net, and standard 2.7-gram, 40 mm diameter table tennis balls.	To test compliance with ITTF standards, the system is placed on a table that is 2.74 meters long and 1.525 meters wide to verify proper fit. The system is then tested with a 15.25 cm high net to ensure that the balls clear the net during launch. Standard table tennis balls with a weight of 2.7 grams and a diameter of 40 mm are used to confirm that the system handles and launches them accurately	The results should confirm that the system fits properly on the specified able dimensions, launches balls that clear the 15.25 cm high net, and functions correctly with standard table tennis balls. This ensures that the system meets the ITTF specifications for table and ball dimensions and adheres to the standard table tennis rules.
The power consumption of the system should be minimized.	The machine should operate on standard mains electricity (220-240V, 50-60 Hz). Also, it should not consume more than 2000W.	The power consumption of the system can be tested by measuring the electrical usage during operation. The system should be connected to a standard mains electricity supply (220-240V, 50-60 Hz). A power meter should be used to measure the system's total power consumption, ensuring that it does not exceed 2000W. This test should be performed while the system is running under typical operating conditions, and he results should confirm that the power consumption remains within the specified limit.	The equipment required for this test includes a power meter to measure the system's total power consumption, and a standard mains electricity supply (220-240V, 50-60 Hz).	The system is connected to a standard mains electricity supply (220-240V, 50-60 Hz), and a power meter is used to measure its electrical usage during operation. The system is run under typical operating conditions, and the total power consumption is recorded. The measurement is analyzed to ensure that the system's power consumption does not exceed 2000W.	The results should confirm that the ystem's power consumption remains within the specified limit of 2000W while operating under typical conditions. This test ensures that the system complies with the requirement for minimized power consumption.

The total cost of the system should be kept within the assigned budget.	Total spending for the prototype of the design should be kept within 300 USD.	The total cost of the system can be tested by tracking all expenses involved in the design and prototype construction. Each component and material used should be priced, and the total spending for the prototype must be calculated. The final cost should be compared to the assigned budget, ensuring that it does not exceed 300 USD. This test should be repeated to confirm that all costs are accurately accounted for, and the total spending remains within the specified budget.	The equipment required for this test includes a list of all components and materials used in the design, as well as access to pricing information for each item. A calculator or spreadsheet software is necessary to track and calculate the total expenses.	The total cost of the system is tested by tracking all expenses related to the design and prototype construction. Each component and material used in the system is priced, and the total spending for the prototype is calculated. The final cost is then compared to the assigned budget to ensure it does not exceed the 300 USD limit. This process is repeated to verify that all costs are accurately accounted for.	The results should confirm that the total spending for the prototype does not exceed the 300 USD budget. This test ensures that the system is developed within the financial constraints, meeting the cost requirement.
The design should be portable, i.e., one person should be able to transport the unassembled system by themselves.	The design, when unassembled, should fit inside a 1 m3 box.	The portability of the system can be tested by attempting to transport the unassembled components by one person. The system should be able to fit comfortably inside a 1 m³ box when disassembled. This can be verified by measuring the dimensions of the unassembled system and ensuring it fits within the specified volume. Additionally, the user should be able to carry the box without assistance, confirming that it is lightweight and manageable for one person to transport.	The equipment required for this test includes a measuring tape or ruler to measure the dimensions of the unassembled system, a 1 m³ box, and a person to test the portability by carrying the box.	The test involves disassembling the system and measuring its components to ensure they fit comfortably inside a 1 m³ box. The dimensions of the unassembled system are compared to the box's size to confirm it fits within the specified volume. Additionally, one person should attempt to transport the box to ensure that it is lightweight and manageable for a single individual.	The results should confirm that the system, when unassembled, fits inside the 1 m³ box and can be transported by one person. This test ensures that the design is portable and meets the requirement for easy transportation.

