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PROTOTYPE DEVELOPMENT FOR AN ERGONOMICALLY-DESIGNED INFANT WALKER

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Abstract

The study discussed that this is due to the most parents also believe that the use of walkers accelerates the development of independent walking skills among infants. The parents also believe that the incorporation of infant walkers in a child's growth accelerates the development of independent walking skills.

Keywords: Prototype, Walker, Designed

Introduction (TIOC Approach)

Infant walkers are frequently used among infants over the years. Studies have reported that 64%-92% of children below one year of age use walkers. Infant walkers have been in use since the 17th century; however, during the last three decades, due to reports about injuries associated with infant walkers, questions have been raised about the safety of and rationality for using baby walkers (Ghotbi and Yavari, 2010).

The use of baby walker is based on cultural beliefs and personal interests of parents. This is because most parents also believe that the use of walkers accelerates the development of independent walking skills among infants. Parents also believe that the incorporation of infant walkers in a child's growth accelerates the development of independent walking skills.

Despite the popularity of infant walkers, there are notable concerns about them. They are highly associated with accidents and injuries, happening in 12% to 50% of users. Also, pediatricians emphasize that the use of infant walkers shows no substantial value in the development of a child's motor skills. First, they provide precocious locomotion in infants, which may interfere with the natural process that an infant needs to develop. Second, they prevent visual experience of moving limbs because of their design which are believed to have a critical role in development of motor systems (Badihian, Adihian, and Yaghini, 2017). Due to existing issues on safety and design of infant walkers leading to accidents and delayed development among children, Canada and the American Academy of Pediatrics suggested banning the manufacture and marketing of infant walkers (Patricia Burrows, 2002).

This study is the second phase on the development of an ergonomically-designed infant walker. An initial study was able to evaluate the present infant walker design through anthropometry and product usability evaluation. Also, the initial phase was able to generate a preliminary design for an ergonomic infant walker. The study will focus on the creation of a prototype based on the results of the initial study which dealt with the ergonomic interventions on the existing design of an infant

walker. In addition, market desirability of infant

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walkers remains high despite pressing issues. This provides a window of opportunity to develop an infant walker prototype which can comply with existing safety standards and promote proper physical development among children.

Theoretical/Conceptual Framework (Sec Approach)

In developing a prototype for an ergonomically-designed infant walker, the study will be using a waterfall diagram to describe the study's framework.

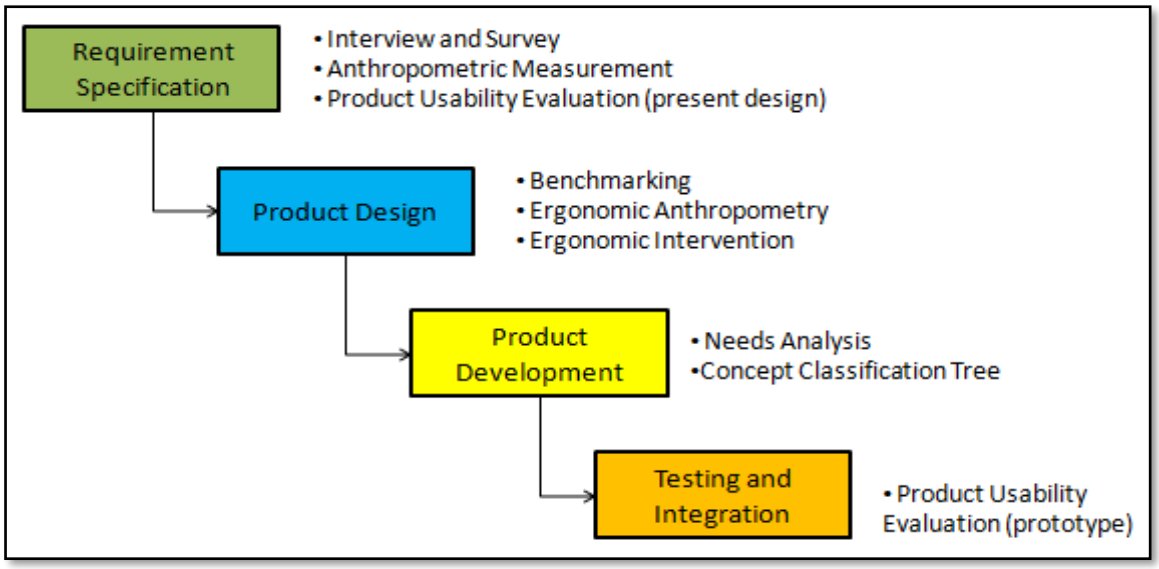

Figure 1: Waterfall Diagram for Prototyping of an Ergonomically-Designed Infant Walker

Requirement Specification. This part of the prototype development deals with the collection of data that will be used for the design conceptualization of the walker. Interviews and surveys were already done during the initial phase of the study. During surveys and interview, anthropometric measurements or body measurements of infants were also taken into account.

Product Design. The design phase is divided into two sub-phases which includes the logical and physical phase. The logical phase of the product design covers the development of possible solutions to issues existing on a walker's present design. Some interventions that were proposed during the initial study includes: (a) adjustability of walker, (b) spreading out of leg braces, (c) locking mechanism for wheels, (d) mounting of motion sensors, and (e) detachable and interchangeable parts.

For the physical phase of the product design, the initial study was able to generate a proposed design for an infant walker. Dimensions of the walker were based on ergonomic anthropometry which enables height adjustment that prevents idiopathic tip-toe walking among infant users.

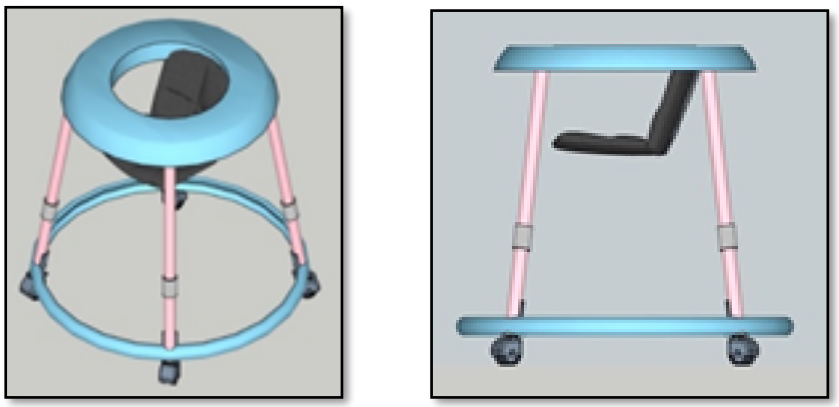

Figure 2: Proposed Design for an Ergonomically-Designed Infant Walker

Product Development. This phase is the focus of the study which deals with the development of an actual prototype for an ergonomically-designed infant walker based on the proposed design. The product development deals with the selection of appropriate materials for the walker. In order to develop a proper prototype, a concept classification tree is used. Generation of product concepts is more effective through concept classification tree. A classification tree labels, records, and assigns variables to discrete classes. In this case, all the customer's desired characteristics and functions of the walker were listed. From there, all the possible materials that can make the said characteristics and functions exist were recorded.

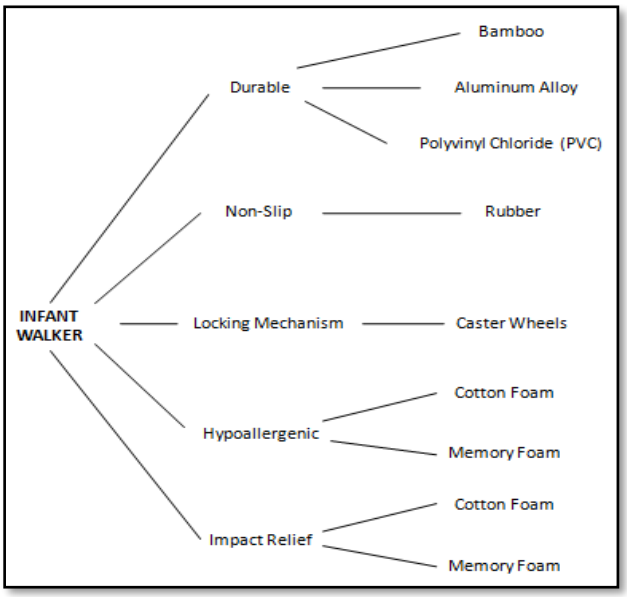

Figure 3: Concept Classification Tree for an Ergonomically-Designed Infant Walker

Table 1: Bill of Materials and Estimated Cost of Ergonomically-Designed Infant Walker

Bill of Materials				
Direct Materials				
Level	**Part Name**	**Quantity**	**Make or Buy**	**Amount (in Php)**
0	BabyUp	1 pc	Make	-
1	Upper Tray	1 pc	Make	-
2	Polyehtylene Granules	2 kg	Buy	93.33
2	Colorant	¼ kg	Buy	10.00
1	Lower Base	1 pc	Make	-
2	Polyehtylene Granules	1 kg	Buy	46.65
2	Colorant	¼ kg	Buy	10.00
1	Brace	1 pc	Make	-
2	Aluminum Alloy	8 pcs	Buy	480.00
1	Assembly	1 pc	Make	-
2	Bolts	16 pcs	Buy	80.00
2	Nuts	16 pcs	Buy	80.00
2	Fabric	½ yard	Buy	70.00
2	Foam	½ pc	Buy	70.00
2	Caster Wheels	4 pcs	Buy	360.00
Total Cost Per Unit (in Php)				**1,300.00**

Testing and Integration. The final phase for prototyping will consist of an evaluation of the ergonomically-designed infant walker. The prototype will be subjected to a product usability

evaluation that will assess the prototype which includes the scope of: need and purpose of design, protective features, design standard, and maintainability. Results will be compared to the product usability evaluation of the existing infant walker design.

Statement of the Problem

- What are issues with the existing infant walker design?
- What are the features needed to develop an ergonomically-designed infant walker?
- What are the materials needed to develop an ergonomically-designed infant walker?

Scope and Delimitation

The study is focused on the development of a prototype for an ergonomically-designed infant walker. The study includes measuring body parts of infants. The study will be conducted approximately for 12 months due to the difficulty of data acquisition especially during the pandemic.

Ethical Consideration/S

An informed-consent form was attached to the aforementioned research instrument stating on how, what, and why the data were collected, processed and stored, as well as, a disclaimer that all gathered data would be used for academic or scholarly purpose only and would be destroyed upon the completion of the reports. Also, permission from the parent or guardian to gather body measurement of the infant was accounted in the informed-consent form.

Methodology

• Research Design

The study follows a cross sectional Product Usability Evaluation; the pre-task survey gathered the demographic profile of the infant and the initial evaluation of their parents' and or guardian experience with infant walker, while the existing design is evaluated using a project dashboard which includes the scope of: Need and purpose of the design, Protective features, Design standard, Maintainability, Optimization of designs, together with a schema-congruity evaluation.

• Participants/Respondents of the Study

The focus of the study is the infants and their body dimensions though the respondents of the survey are the guardians and parents. Using Slovin's formula (Tejada & Punzalan, 2012) to calculate the sample size, it was approximated that 400 infants together with their care taker/ parent would be required to obtain ±0.05 or 5% margin of error. However only 273 were able to accomplish the instrument, giving a study error of ± .06 or 6%.

• Instrument/s of the Study

The project dashboard form used a 5-point Likert Sale with a Cronbach Alpha of 0.83 with 5 being "State of Art" and 1 being "Needs Significant Attention".'

• Data Collection and Analysis

The study used descriptive statistics for the demographics and anthropometric measurements from the pre-task survey while one sample z test ratifies the quantitative and qualitative assessment from the project dashboard. In order to gather data, a survey questionnaire would be provided among parents and guardians via email and Facebook messenger in a form of a Google form questionnaire which should be answered thoroughly.

Results and Discussion

Market Aspect

Market aspect of the prototype development of the walker was considered in the study. This is in preparation for possible potential of the prototype for commercialization. Table 2 shows a projected population growth for Greater Manila Area.

Table 2: GMA Total Annual Population and Population Growth

Year	Population	Population Growth
2019	34,588,500.00	-
2020	35,432,459.40	843,959.40
2021	36,297,011.41	864,552.01
2022	37,182,658.49	**885,647.08**
2023	38,089,915.35	**907,256.87**
2024	39,019,309.29	**929,393.93**
2025	39,971,380.44	**952,071.15**
2026	40,946,682.12	**975,301.68**

After determining the population of babies born each year in GMA, the proponents also identified the socio-economic class wherein babies fall into. Socio-economic classes are hierarchical

representation of individuals based on the annual income each earns. There are five (5) general socio-economic classes ranging from Class A to Class E. According to a survey done by the Social Weather Station (SWS) in 2015, Class A and B constitute 1% of the country's population, while Class C is comprised by 9% of the total population from here; the proponents have determined the portion of the annual population growth that belongs to Class A, B and C.

Table 3 shows how the proponents have determined market sizes that became the basis for developing projected sales for a five-year planning horizon. The proponents have extracted the number of babies that are born to A and B classes from the annual population growth brought by live births.

Table 3: Potential Market Size for Walker Production

Year	Class	Share in Population	Population Growth	Portion of Classes to Population	10% Target Market Share	Market Size
2022	AB	1%	885,647.08	8,856.47	885.65	**8,856.47**
	C	9%	885,647.08	79,708.24	7,970.82	
2023	AB	1%	907,256.87	9,072.57	907.26	**9,072.57**
	C	9%	907,256.87	81,653.12	8,165.31	
2024	AB	1%	929,393.93	9,293.94	929.39	**9,293.94**
	C	9%	929,393.93	83,645.45	8,364.55	
2025	AB	1%	952,071.15	9,520.71	952.07	**9,520.71**
	C	9%	952,071.15	85,686.40	8,568.64	
2026	AB	1%	975,301.68	9,753.02	975.30	**9,753.02**
	C	9%	975,301.68	87,777.15	8,777.72	

Prototype Development

In order to develop a proposed design for the product, the researchers used anthropometry to determine the appropriate dimensions for ach part of the product. The researchers determined which body dimensions will be needed as reference for the proposed product dimensions.

Table 4: Walker Parts and Body Dimension Reference

Parts	Body Dimension Reference
Walker – High Chair Height (Adjustable)	Height
Back Rest Height	Seated Shoulder Height
Seat Width	Buttock Popliteal Length
Seat Length	Hip Breadth
Baby Cockpit Length	Chest Breadth
Baby Cockpit Width	Chest Depth

Table 4 shows which body portions were used by the proponents to developed dimensions for each part of the walker. The proponents used anthropometry to develop a walker that will accommodate varying sizes of babies. The most important feature of the product is its adjustability in terms of height which was subjected to anthropometric analysis. The proponents focused on making the product height adjustable to prevent babies from slouching or tip-toe walking.

From these body references and walker part an anthropometric analysis was conducted. Table 5 shows the result of the analysis.

Table 5: Anthropometric Dimensions of Infant Users

Body Dimensions (in CM)								
	Weight	Height	Popliteal Height	Hip Breadth	Buttock Popliteal Height	Buttock Knee Length	Chest Breadth	Chest Depth
MAX	9.8	88	19.5	19	25	22	20	18
MIN	6.5	70	13	11.8	15	13	11.6	11
MEAN	7.77	77.88	16.61	15.93	19.55	18.75	16.14	14.11
STD DEV	0.76	5.05	1.49	1.74	2.68	2.08	1.88	1.53

The maximum and minimum body dimensions of infants were considered in developing the walker's design. These dimensions are consistent with the standard dimension of infants (0-24 months), specifically in height, established by the World Health Organization Child Growth Standard and PH National Nutrition Council in 2015 as shown in table 6.

Table 6: Standard Height of Filipino Infants

Age (months)	Length (cm)					
	Severely Stunted	Stunted		Normal		Tall
		From	To	From	To	
	< -3SD	-3SD	< -2SD	-2SD	+2SD	> +2SD
0	44.1	44.2	46.0	46.1	53.7	53.8
1	48.8	48.9	50.7	50.8	58.6	58.7
2	52.3	52.4	54.3	54.4	62.4	62.5
3	55.2	55.3	57.2	57.3	65.5	65.6
4	57.5	57.6	59.6	59.7	68.0	68.1
5	59.5	59.6	61.6	61.7	70.1	70.2
6	61.1	61.2	63.2	63.3	71.9	72.0
7	62.6	62.7	64.7	64.8	73.5	73.6
8	63.9	64.0	66.1	66.2	75.0	75.1
9	65.1	65.2	67.4	67.5	76.5	76.6
10	66.3	66.4	68.6	68.7	77.9	78.0
11	67.5	67.6	69.8	69.9	79.2	79.3

Age (months)	Height (cm)					
	Severely Stunted	Stunted		Normal		Tall
		From	To	From	To	
	< -3SD	-3SD	< -2SD	-2SD	+2SD	> +2SD
24	77.9	78.0	80.9	81.0	93.2	93.3
25	78.5	78.6	81.6	81.7	94.2	94.3
26	79.2	79.3	82.4	82.5	95.2	95.3
27	79.8	79.9	83.0	83.1	96.1	96.2
28	80.4	80.5	83.7	83.8	97.0	97.1
29	81.0	81.1	84.4	84.5	97.9	98.0
30	81.6	81.7	85.0	85.1	98.7	98.8
31	82.2	82.3	85.6	85.7	99.6	99.7
32	82.7	82.8	86.3	86.4	100.4	100.5
33	83.3	83.4	86.8	86.9	101.2	101.3

Also, in order to incorporate the perspective of parents and guardians in terms of prototype development, a product usability evaluation was conducted using a 5-point Likert scale survey which assesses an infant walker in terms of the following design aspects: (a) need and purpose, (b) protective features, (c) design standards, and (d) maintainability. Below is the result of the product usability evaluation.

Table 7: Product Evaluation Result

ITEM	ITEM MEAN	INTERPRETATION
Need and purpose of design	4.84	State of the Art
Protective features	2.14	Needs Attention
Design standard	4.21	Above Expectation
Maintainability	1.45	Needs Attention

Conclusion and Recommendation

From the four design aspects that have been evaluated, protective features and maintainability are assessed as being in need of attention. These two design aspects have been the primary focus of the prototype's design development.

Dimensions for the designs of the baby walker should be within the 95th and 5th percentile of the infant. Also, safety protection is included which are as follow:

- Leg braces must be spread out.

- Lower base must be covered with foam.
- Wheels must have locking a mechanism.
- Seat must be made up of memory foam.

For maintainability, it is recommended that parts are detachable and are interchangeable.

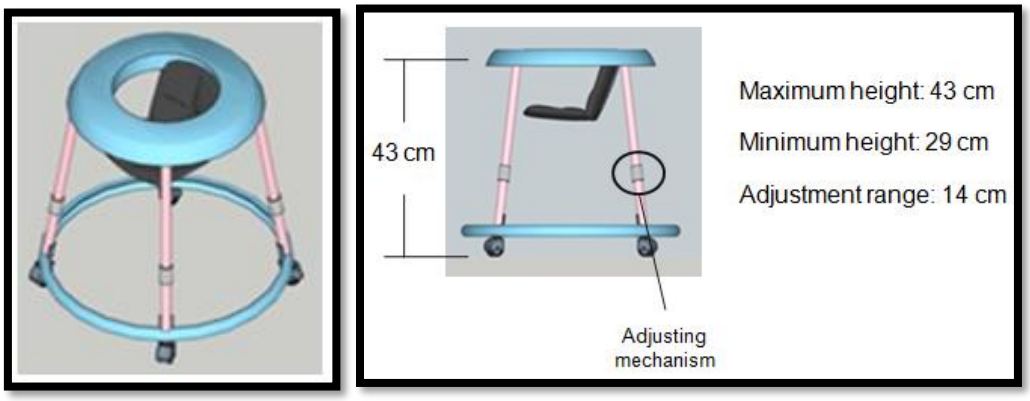

Figure 4: Walker Dimension and Design

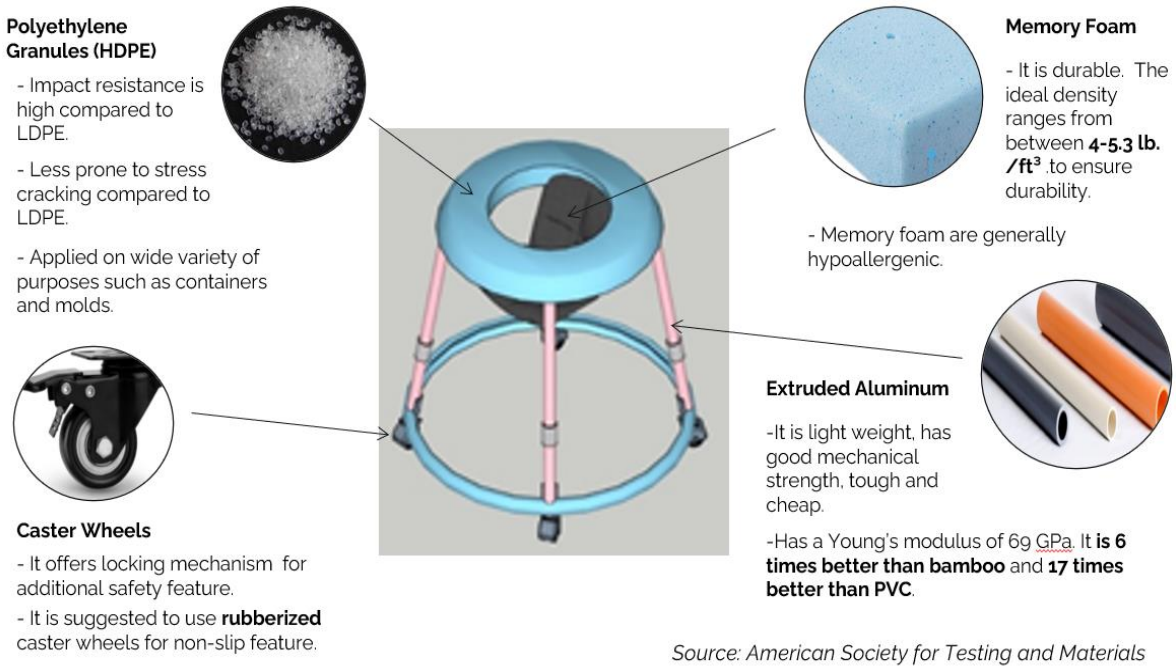

Figure 5: Material Selections for Proposed Prototype

Conflict of Interest

There is no conflict of interest between the authors in this manuscript.

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