Conceptual design and prototype of an ergonomic back-leaning posture support for motorbike riders

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This study presents a prototype of an ergonomic back-leaning posture support for motorbike riders. The design was developed to improve comfort and reduce musculoskeletal disorders such as lower back pain. The prototype consists of two basic components, frame and backrest cushion. Prototype testing was conducted on road to evaluate its performance in terms of comfort, adjustability, stability, solidity, durability and safety for riders.

Keywords: Back posture support, Ergonomic, Lower back pain, Motorbike

Introduction

Many major motorbike markets in Asian region comprise over half the vehicle fleet in most Asian countries. Motorbike riders are relatively more exposed to musculoskeletal disorders such as lower back pain. Current design of motorbike in market is not equipped with back leaning posture support features for riders. International Ergonomics Association defined ergonomics as a scientific discipline to design and optimize human well-being while interacting with industrial product. There is very limited available adjustment to suit different needs of motorbike riders. Any aspect of motorbike design that may constrain user and interfere with operation of vehicle, needs to take into account attributes of workplace to the user. Ergonomic principles are valuable in providing basic scientific information, regarding unsupported back-leaning seating posture among motorbike riders.

There are three types of work posture (standing, sitting or sit-standing). Motorbike riders are normally associated with sitting posture during riding bike. Studies show that sitting without lower back support will generate pain in lower back and while sitting without back support will generate pain in central back. Back posture for human in lumbar area are one of the most common health complaints since ancient times.

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Fig. 1—Ergonomic comfort area for riders

Fig. 2—Dissection of body posture parts
times\textsuperscript{3,9-13}. Low-back pain occurring in adults (50-90\%) with high recurrence rates\textsuperscript{14-21} (up to 90\%) is most common in musculoskeletal disorders (MSDs). Intradiscal pressures in lumbar region of spine can actually be greater while seated than standing\textsuperscript{14,25,26}.

This study presents development and designing of a prototype of an ergonomic back-leaning postures support for motorbike riders.

### Table 1—Product design specification (PDS) for back-leaning posture support

<table>
<thead>
<tr>
<th>No.</th>
<th>Criteria</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Performance</td>
<td>A good rigid frame. It can support maximum body weight (90 kg). It can be adjustable upward and downward according to lumbar height and forward and backward according to rider’s comfortability.</td>
</tr>
<tr>
<td>2</td>
<td>Environment</td>
<td>It can withstand hot and cold temperature, vibration, corrosion (rain water), shock loading of riders and dirt and dusty environment.</td>
</tr>
<tr>
<td>3</td>
<td>Life in services</td>
<td>It can withstand for 5 years.</td>
</tr>
<tr>
<td>4</td>
<td>Maintenance</td>
<td>Twice a year; does not need special tools for maintenance and spare parts are cheap and easy to obtain.</td>
</tr>
<tr>
<td>5</td>
<td>Size</td>
<td>It should fit to present motorbike seat’s dimension.</td>
</tr>
<tr>
<td>6</td>
<td>Weight</td>
<td>&lt; 1 kg</td>
</tr>
<tr>
<td>7</td>
<td>Material</td>
<td>Light, strong, anti-rust, easy to form shape, less expensive and easy for machining.</td>
</tr>
<tr>
<td>8</td>
<td>Aesthetics</td>
<td>Bright colours, reflect light during night riding, curved edges, simple and fulfill needs and sporty look.</td>
</tr>
<tr>
<td>9</td>
<td>Ergonomic</td>
<td>Cushion (contour shape) will support back posture. Adjustable seat height according to rider’s lumbar height. Less sharp edges.</td>
</tr>
</tbody>
</table>

![Fig. 3—Total design activity model](image)

![Fig. 4—New registered motor vehicles by type in Malaysia, 1996-2005](image)
Methodology

Development of ergonomic prototype of back leaning postures support for motorbike riders is based on Total Design Activity Model (Fig. 3). Malaysian Road Transport Department Statistics of new registered motor vehicles for 1996-2005 (Fig. 4) shows that motorbikes are commonly used in Malaysian society for commuting. Motorbikes with and without back support in Malaysia have been studied under existing market product of DAM. Existing motorbike design does not contain a back posture support for riders. For back posture support design, there are 32 important criteria (Fig. 5) of product design specification (PDS), of which 9 relevant criteria are chosen (Table 1).

Development of a Back-Leaning Posture Support

Based on PDS, following conceptual designs were developed:

Concept 1

It has following features (Fig. 6, concept 1): i) Contour shape on cushion will provide support to rider’s lumbar; ii) Use belt and hook to hold base frame with seat; iii) Base frame quite large and occupied a large area of motorbike seat; iv) Adjustable back rest height; v) Adjustable back rest angle; and vi) Adjustable of four belts and hook according to motorbike seat height.

Concept 2

It has following features (Fig. 6, concept 2): i) Flat type without none contour shape of cushion to support lumbar; ii) Use belt and hook to hold base frame with seat; iii) Small base frame; iv) Adjustable back rest height; v) Adjustable back rest angle; vi) Adjustable back rest frame angle; and vii) Adjustable of four belts and hook according to motorbike seat height.
<table>
<thead>
<tr>
<th>Concept</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong / good stability from vibration</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Adjustable height or width</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Easy to assemble</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Small base frame</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Light weight</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Attractive</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Easy to move around</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Easy for maintenance</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Σ +</td>
<td>4</td>
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<tr>
<td>Σ −</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 6 — Conceptual design evaluation using matrix method

Fig. 7—Selected conceptual design (Concept 5)
Concept 3
It has following features (Fig. 6, concept 3): i) Attractive cushion design and can provide lumbar support; ii) Adjustable back rest height; iii) Adjustable back rest angle; iv) Adjustable back rest frame angle; v) Use a separate belt and hook with slot concept to hold base frame with seat; vi) Adjustable base frame width; vii) Adjustable base frame height from motorbikes seat; and viii) Use belt to hold base frame slot to seat.

Concept 4
It has following features (Fig. 6, concept 4): i) Attractive and sporty cushion design; ii) Adjustable back rest height; iii) Adjustable back rest angle; iv) Adjustable back rest frame angle; v) Use a separate belt and hook with slot concept to hold base frame with seat; vi) Adjustable base frame width; vii) Adjustable base frame height from motorbikes seat; viii) Use belt to hold base frame slot to seat; and ix) Use a square and wide base holder.

Concept 5
It has following features (Fig. 6, concept 5): i) Attractive and sporty cushion design; ii) Adjustable back rest height; iii) Adjustable back rest angle; iv) Adjustable back rest frame angle; v) Use a separate belt and hook with slot concept to hold base frame with seat; vi) Adjustable base frame width; vii) Adjustable base frame height from motorbikes seat; and viii) Curved base frame.

Based on conceptual design and using evaluation of matrix method\textsuperscript{27,28}, most suited design fulfilling PDS is chosen (Fig. 6).

Results
Based on evaluation points (Fig. 6) for each design product, Concept 5 is chosen as the most suited design concept for motorbike back posture support (Fig. 7). A test run (Fig. 8) using back posture for riders proved satisfactory for ergonomic parameters (adjustability, stability, solidity, durability and safety). There is no correlation between sitting posture support and ergonomic parameters\textsuperscript{29,30}. Therefore, it is important to evaluate comfort ratings, adjustability, stability, solidity, durability, and safety by conducting tests on actual user groups\textsuperscript{29}.

Conclusions
This study focused on designing and testing a prototype of an adjustable back-leaning posture support for motorbike riders in Malaysia. The developed back posture support enhances level of conformability and health protection particularly in lumbar area for riders. Back posture support helps riders to maintain a proper body posture during riding. Also, these back posture supports are designed with criteria of ergonomic and aesthetics to attract riders to use it. The design is also suited for any type of motorbike models as component can be adjustable according to seat dimension without any modifications on motorbikes. Fitting trials also proved to satisfy riders on test runs.

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References