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Exploring Outcome-driven Innovation for the Responsible Design of Electric Two-wheelers

Michael Thelen[1], Veronika Hornung-Prähauser[2], Claudia Luger-Bazinger[3], and Sebastian Will[4]

[1]Salzburg Research Forschungsgesellschaft m.b.H., Jakob-Haringer-Straße 5/3, 5020 Salzburg, Austria | *michael.thelen@salzburgresearch.at*
[2]Salzburg Research Forschungsgesellschaft m.b.H., Austria | *veronika.hornung@salzburgresearch.at*
[3]Salzburg Research Forschungsgesellschaft m.b.H., Austria | *claudia.luger-bazinger@salzburgresearch.at*
[4]Würzburger Institut für Verkehrswissenschaften, Germany | *will@wivw.de*

Abstract

Amidst a technology push for electric mobility, the societal implementation of new e-mobility innovations is multi-layered and warrants a user-centered view. This study explores how the application of the outcome-driven innovation method (ODI) can be extended to e-mobility and inform a more responsible design of electric two-wheeler product and service development. By means of discovering electric two-wheelers' possible weak spots and potentials using outcome-driven innovation with citizens, their unmet requirements can be better addressed. The results suggest several innovation potentials which could better facilitate users in getting certain jobs done, such as developing a more lightweight vehicle design. Additionally, the diverse needs of users can be transformed into real customer benefits through the subsequent integration of additional vehicle functionalities, such as complementing human machine interfaces or wearables. By employing outcome-driven innovation as a deliberative and inclusive means of creating value and by being receptive to citizen feedback, ODI has the potential to make a meaningful stride in enhancing the 'responsible' nature of innovation.

Keywords: Outcome-driven Innovation; Design thinking; E-mobility; Responsible Innovation; User Study; Electric Two-wheeler; JTBD; Innovation Potential; Product Development.

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1 The changing nature of the mobility sector

The European Union's target of a 37.5% reduction in carbon dioxide emissions by 2030 for new vehicles is increasingly facilitated by the uptake of electric L-category vehicles[1] (ELVs), which play a prime role in the modal shift revolution in personal mobility from cars to lighter, smaller, and more environmentally sustainable vehicles (Santucci et al., 2016). They are also key to decarbonizing where it matters most, e.g., in urban and periphery areas. As the current electric-

1. Electric L-category vehicles (ELV) comprise light two-wheel vehicles (L1e), three-wheel mopeds (L2e), two-wheel motorcycles (L3e), two-wheel motorcycles with side car (L4e), powered tricycles (L5e), light quadricycles (L6e), and heavy quadricycles (L7e) (Consolidated Resolution on the Construction of Vehicles (R.E.3) Revision 6, 2017).

powered two-wheeler[2] (E-PTW) market stands, many vehicles are designed for very specific target groups with low adaptability between different vehicle classes. Subsequently, there exists a lack of E-PTWs that cover the whole range of ages that help users to become mobile (young generation) and to support users staying mobile (50+ users). Such customer groups have diverse vehicle needs, such as the younger generation's tendency to place importance on integrating their two-wheeler with public transport (Institut für Mobilitätsforschung, 2011) or women's greater necessity to run errands (Knoope & Kansen, 2021). Therefore, the gap between electric mopeds and electric motorcycles must be closed by means of bridging the existing vehicle offerings between 500 W and 11 kW (light vehicle class L1e-B or L3e-A1), by means of developing an E-PTW design that adheres to multiple target markets.

Concurrently, in the past two decades, mobility solution providers have had to confront the forces of globalisation, digitization, and environmental sustainability (Zahinos et al., 2013). Additionally, technology push due to enforced government quotas and standards have hastened automotive makers' electric mobility research and development (Schot & Rip, 1997). Due to this, mobility providers have been called to follow suit and to create a quicker, user-centric and responsible innovation process to tackle an onset of economic, social and environmental challenges (Zahinos et al., 2013). As an innovation is socially constructed and negotiated (Winner, 1993) and therefore is 'society in the making' (Callon, 1987), future innovations in electrified mobility stand to benefit from a user-facing and responsive design.

Responsible research and innovation – "a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society" (Von Schomberg, 2013, p. 19) – has come to the fore as a means to critically question an innovation's uncertainty, objectives, motives, social components and research trajectories. By deliberating upon these points in the innovation process, responsible innovation presents a framework among four dimensions: anticipation, reflexivity, inclusion and responsiveness (Stilgoe et al., 2013). Responsible innovation within the realm of e-mobility has been explored by authors, such as Hess et al. (2021), which suggested an open, sociotechnical design approach to responsible innovation concerning policy and technological development among social scientists, engineers and scientists. However, there are deep challenges within the responsible innovation paradigm's research and governance, namely that it does not provide a guaranteed and full proof way of foreseeing the social implications or the responsible design of technologies (Stilgoe et al., 2013). Another shortcoming of responsible innovation is its lack of application into industry, as incorporating responsible innovation into firms' R&D is seen by some to hinder market competitiveness (Hess et al., 2021). With that being said, incorporating a more business-oriented innovation methodology that enhances market competitiveness by solving customer problems while at the same time innovating in a societally responsive manner can serve as a bridge to inform the product and service design of emerging technologies – resulting in mutually-beneficial exchanges between research and industry.

Therefore, this research investigates the question of how to extend responsible innovation to the e-mobility industry by means of exploring a new method of increasing the user-facing value proposition. This is done by introducing the outcome-driven innovation method proposed

2. Electric-powered two wheelers (E-PTW) are a subset of ELVs and comprise light-two wheel vehicles/mopeds, which are motorcycles with low power drivetrains designed for low speed driving (L1e) and two-wheel motorcycles (L3e) (Consolidated Resolution on the Construction of Vehicles (R.E.3) Revision 6, 2017).

by Ulwick (2005) to support the product and service design process of electric two-wheelers by providing insight into their users' needs.

2 A paradigm shift: situating the context of responsible innovation

Since the 1970s, the notion of corporate social responsibility, a firm's growing awareness of their social responsibility, involves their attempt in addressing external societal causes (Gassmann et al., 2014), with a greater "integration of sustainability and externalities into the 'corporate DNA' " (Walkiewicz et al., 2021, p. 1). Recently, responsible research and innovation has been a priority of the European Commission, as it "encourages societal actors to work together during the whole research and innovation process to better align research and innovation and its outcomes with the values, needs and expectations of society" (European Commission, 2020, p. 5). Here, the responsibility of an innovation's development is shared – whether it be by researchers, funding agencies, innovators and others possess a collective responsibility for research integrity (Mitcham, 2003). This marks a departure from the view that stakeholders are a "nuisance or opportunity that needs to be managed" (Jones et al., 2005, p. 123), in favor of willing engagement with the public (Stilgoe et al., 2013). In this context, citizens are not merely passive users who generate demand for new products and services, but also as a significant influence to be heard as their perceptions have value (Robinson et al., 2020).

Traditionally, companies would derive value from closed innovation silos. However, Curley and Salmalin (2018) observe that who takes on the role of the innovator is becoming increasingly indistinct, whether it be universities, industry, governments, users or communities. Recent literature suggests that there is just as much value gained from external ideas as there is with internally held ideas to innovate product and service offerings and in turn create value, with the "end of knowledge monopolies in sight" (Chesbrough, 2003, p. 45). It is suggested that "the consumer is an integral part of the system for value creation, and the consumer can influence where, when, and how value is generated" (Ramaswamy & Prahalad, 2002, p. 4). Increasingly, firms are embracing user inputs as a way to innovate quicker, ensure their product design is profitable and to keep their competitive advantage (Tapscott & Williams, 2006). Furthermore, user-led innovation and its possibilities have been extensively examined by authors such as Von Hippel (2005), where users meaningfully contribute to the development of new products and services.

Oftentimes, responsibility in science and innovation has been centered around assessing innovations' impacts which are later found to be insufficient or destructive (Stilgoe et al., 2013). Likewise, a common route of anticipating technological impact has taken the form of formal government risk assessments, however, they have often fallen short of producing the proper foresight of their impacts (Muniesa & Lenglet, 2013). In order to have a greater interlinkage of responsibility in technology design and development, different types of Technology Assessment have been created, such as the Constructive TA method, which draws the emphasis away from evaluating the impacts of new innovations towards the innovation's design, development, and application (Schot & Rip, 1997). In a similar vein from business literature, the method of outcome-driven innovation (ODI) challenges the conventional business practice of testing an innovation's value only ex-post after its development, in favor of measuring how customers assess value to begin with and only thereafter develop an innovation according to these measures – resulting in responsible managerial decision making (Ulwick, 2009). Consequently, practitioners become responsive to rethinking their own beliefs and actions, and thus cultivating more cooperative, receptive and ethical ways of managing firms as critically reflexive moral agents (Cunliffe, 2004).

3 Method

Looking at responsible innovation in terms of a product ex-ante before an innovation's development and commercialization, Ulwick's outcome-driven innovation methodology presents a 'needs-first' innovation strategy that zeroes in on the end customer's precise needs and thereafter formulates targeted innovation designs and processes. This follows the thinking that firms must cease the idea that customer needs correlate to the use of a product or service, and instead need to recognize that needs are linked to how well the customer is getting a certain job done (with the said product); seeking how to aid customers in getting a job done better or facilitate them get other or new jobs done should be the objective of innovation (Ulwick, 2009). This extends the idea that the reason why consumers purchase certain products is nuanced and cannot be fully captured by merely demographic or psychographic information alone (Christensen et al., 2016). This approach argues that consumers will only realize the value of a new socio-technical innovation if the said solution offers considerable alleviations to a customer problem that existing products cannot adequately address (2005). Outcome-driven innovation suggests that customer's needs and purposes of using the product or service in question, so-called 'jobs to be done' (JTBD) are the unit of analysis (Christensen et al., 2016), comprising of a subset of desired outcomes taking the form of statements that the respondent rates (Ulwick, 2005). These unmet needs reveal the greatest innovation potential by informing the introduction of new product functionalities or services which meet these needs. In fact, some of the most successful innovations in recent times, such as Hershey's Reese's Minis and International Delight Iced Coffee, have tackled a poorly executed and very precise job to be done (Christensen et al., 2016). Additionally, analyzing users' JTBD has been readily applied in the realm of e-mobility, e.g., by Febransyah (2021), which explored business executive's JTBD as early adopters of electric vehicles; and by Popova & Zagulova (2022), which investigated customers' JTBD regarding e-scooter sharing. To the authors' knowledge, the exploration of user's JTBD within the realm of e-mopeds/motorcycles has not yet been conducted.

This study has developed one 4 kW and one 8 kW electric-powered two-wheeler, which envisage to fulfill multiple customer markets and trip purposes with a versatile, inclusive and responsive construction from the outset. In doing so, the project's aim is to create a new opportunity for commuters, whose design is both environmentally responsible and user-centered. This includes appealing to user groups of young (16-18) and older (50+) people, e.g., by incorporating a lightweight and ergonomic vehicle design. Environmental elements, such as the development of vehicle component energy efficiency, and various environmental assessments, such as lifecycle analyses, serve as a complement to the employed user driven innovation methods.

By employing the following method, this research aims to encourage the responsible innovation process of electric-powered two-wheelers by utilizing an inclusive approach. This is facilitated by compiling citizens' perceptions of operating an E-PTW. In doing so, underdelivered needs which are perceived by the sample to hold high importance can be discovered. With that being said, this study's use of the outcome-driven innovation method has been centered upon two of the four pillars of responsible innovation set out by Stilgoe et al., namely inclusion and responsiveness (2013):

(1) *Inclusion* – Inclusion is fostered via including the wider public by means of deliberative polling takes on a participatory approach, where user needs are heard as a challenge to practitioners' and researchers' possible entrenched assumptions;
(1) *Responsiveness* – Responsiveness is demonstrated, as after citizen consultation via the online survey, the vehicle's further R&D will be informed by this very feedback. Here, there is

significant leeway to change the vehicle's R&D course of action based on this feedback.

3.1 Preparation

This study has defined two different JTBD to be further examined, namely (1) *riding a powered two-wheeler to work / university / school*, and (2) *handling the battery in a two-wheeler*. In order to properly define the desired outcomes for the JTBD, individual interviews were conducted via telephone ($N = 5$) among a varied sample in terms of age, gender and commuting purpose who were lead users and had experience with riding two-wheelers and handling their battery. Convenience sampling was used, with possible interviewee contacts circulated among the project consortium.

3.2 User survey

This research integrates the outcome-driven innovation method into an online survey (administered via LimeSurvey in June 2020) to measure JTBD 1 "*riding a powered two-wheeler to work / university / school*" ($N = 206$) and JTBD 2 "*handling the battery in a two-wheeler*" ($N = 121$) among people with experience riding an E-PTW and handling a battery in an E-PTW (however, not our vehicle prototype) in order to identify unmet user needs during E-PTWs' product development. Convenience sampling was used, as the survey was sent out by all partners in the consortium. Here, the JTBD are broken down into single steps of desired outcomes the user needs to follow in order to accomplish the job, which took the form of various statements in the survey. Here, the user was asked how important an aspect (the statement) is to them and how satisfied they currently are with that particular aspect. These values were all quantified on a five-point Likert scale (1 being the lowest, 5 being the highest).

3.2.1. JTBD 1 "riding a powered two-wheeler to work / university / school"

Table 1. Desired outcomes/activities for the job to be done "riding a powered two-wheeler to work / university / school."

Nr.	Desired outcome/activity
1	When I ride my PTW to work or to school, I can store everything I need.
2	Mounting my PTW is easy, even with protective clothing.
3	Before a longer stop, I know in advance where to find a lighted, suitable parking spot for my bike.
4	I can use a navigation aid (e.g. smartphone) while riding without problems.
5	Slippery surfaces on the road (sand, leaves, etc.) are always clearly visible.
6	When riding around bends, I can always assess the necessary radius and lean angle of the PTW.
7	I ride as environmentally friendly as possible (i.e. economical fuel or battery consumption).
8	While riding, the dashboard of my PTW is clearly visible.
9	While riding, making calls is possible without difficulty.
10	The behaviour of other road users can be easily predicted.
11	Speed limits and traffic signs are clearly visible while riding.
12	On the PTW, I feel clearly visible to other road users.
13	Other road users maintain an appropriate distance from me.
14	The PTW can be moved into and out of parking spots without much strength.
15	At my most frequent destinations, I have a weatherproof shelter for my PTW.

Nr.	Desired outcome/activity
16	If necessary, I can also transport things (e.g., groceries) with my PTW.
17	Even after a long day, concentration while riding my PTW is effortless.

3.2.2 JTBD 2 "Handling the battery in a two-wheeler"

Table 2. Desired outcomes/activities for the job to be done "handling the battery in a two-wheeler."

Nr.	Desired outcomes
1	I can charge and store the battery of my electric Two-Wheeler in my home or at work.
2	I am notified (e.g., on my smartphone) when the battery of my electric Two-Wheeler is fully charged.
3	I can remove the battery of my electric Two-Wheeler without exertion and carry it comfortably.
4	I can easily charge the battery of my electric Two-Wheeler on the road, even without a charging station (e.g., at a socket in a café).
5	I would like to receive personalised tips (e.g., on my smartphone) on how and when I can charge the battery of my electric two-wheeler the best.

Although Ulwick formulated a statement's 'opportunity score' via an algorithmic equation[3], due to a lack of cohesion of scales and the somewhat arbitrary nature of such calculations, this study has adopted the Market Opportunity Map of Katz (2008), which sought to address the shortcomings of the ODI method presented by Ulwick (2005). Using this method, the quadrants were calculated by distinguishing the statements which fall either above or below the mean value of importance, and the same was done by distinguishing the statements which fall either above or below the mean value of significance to ensure the employed assessment thresholds were well-suited to this survey's response data. In other words, the mean value for satisfaction and the mean value of importance served as the boundary between quadrants (e.g., a desired outcome ranking below the mean of importance and below the mean of satisfaction would fit into quadrant three). Therefore, the survey statements which hold the most innovative potential (quadrant four) according to Katz's reasoning are those which are so-called *weaknesses* of high importance and low performance: "the needs [in the lower right corner] that customers tell us are very important to them, but they are not currently very satisfied with the options they have available to them. This is the most fertile area in which to *Focus*, i.e. *Invest* and *Innovate*, because fixing these problems will almost always result in significant competitive advantage" (Katz, 2008, p. 24).

4 Results

4.1 Job to be done "riding a powered two-wheeler to work / university / school"

Amongst the sample ($N = 206$), the mean age was 45 (min 20, max 84), with respondents over 50 ($n = 81$) and females ($n = 29$) represented. The most respondents hailed from Germany ($n = 109$), followed by Italy ($n = 48$) and Austria ($n = 21$).

3. Opportunity algorithm: Opportunity score = Importance + *max*(Importance – Satisfaction, 0) (Ulwick, 2005, p. 45)

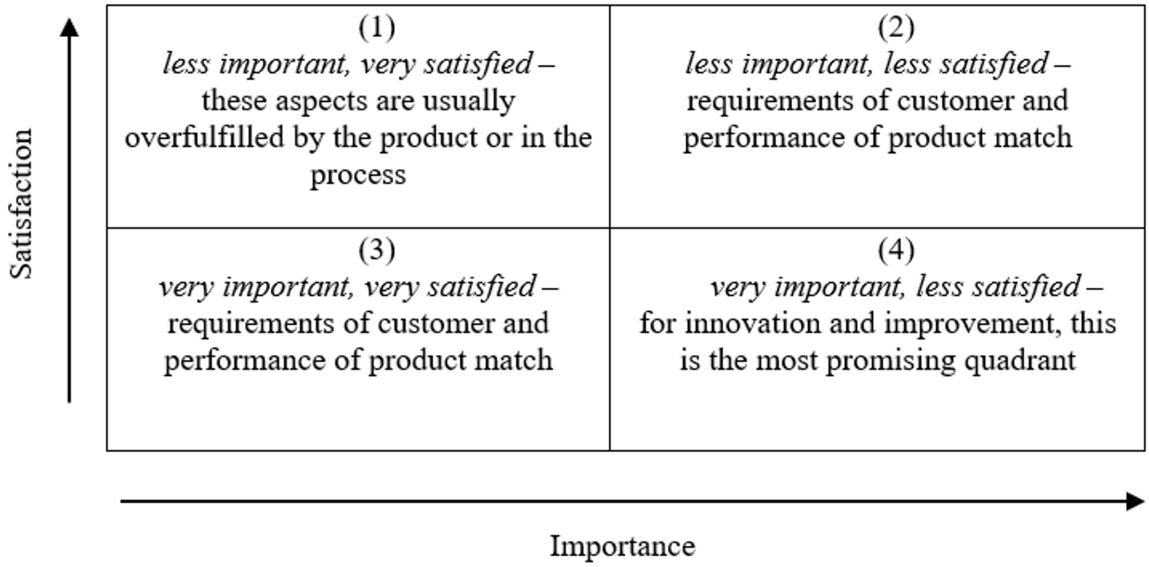

Figure 1. The four quadrants of the Market Opportunity Map (Katz, 2008, pp. 23–24)

Here, four innovation potentials were found for the JTBD *"riding a powered two-wheeler to work / university / school"* (among the whole sample and only women):

5. *"Slippery surfaces on the road (sand, leaves, etc.) are always clearly visible."*
10. *"The behavior of other road users can be easily predicted."*
12. *"On the PTW, I feel clearly visible to other road users."*
13. *"Other road users maintain an appropriate distance from me."*

Furthermore, when examining older participants only (over 50 years old) ($n = 81$), they also expressed one additional important, unsatisfied dimension:

14. *"The PTW can be moved into and out of parking spots without much strength."*

4.2 Job to be done "handling the battery in a two-wheeler"

Amongst the sample ($N = 121$), the mean age was 44 (min 21, max 84), with respondents over 50 ($n = 46$) and females ($n = 27$) represented. The most respondents hailed from Germany ($n = 76$), followed by Austria ($n = 17$) and Italy ($n = 13$).

Here, one innovation potential for the JTBD *"riding a powered two-wheeler to work / university / school"* was found for all respondents (among the whole sample, women, and people over 50), which was categorised into quadrant four:

4. *"I can easily charge the battery of my electric two-wheeler on the road, even without a charging station (e.g., at a socket in a café)."*

5 Conclusion and Recommendations

This study sought to explore the benefit of the ODI method during the design process of electric-powered two-wheelers by shedding light on user requirements. The ODI methodology demonstrated how users' different needs (e.g., "safety", "handling weight" and "handling e-technology" etc.)

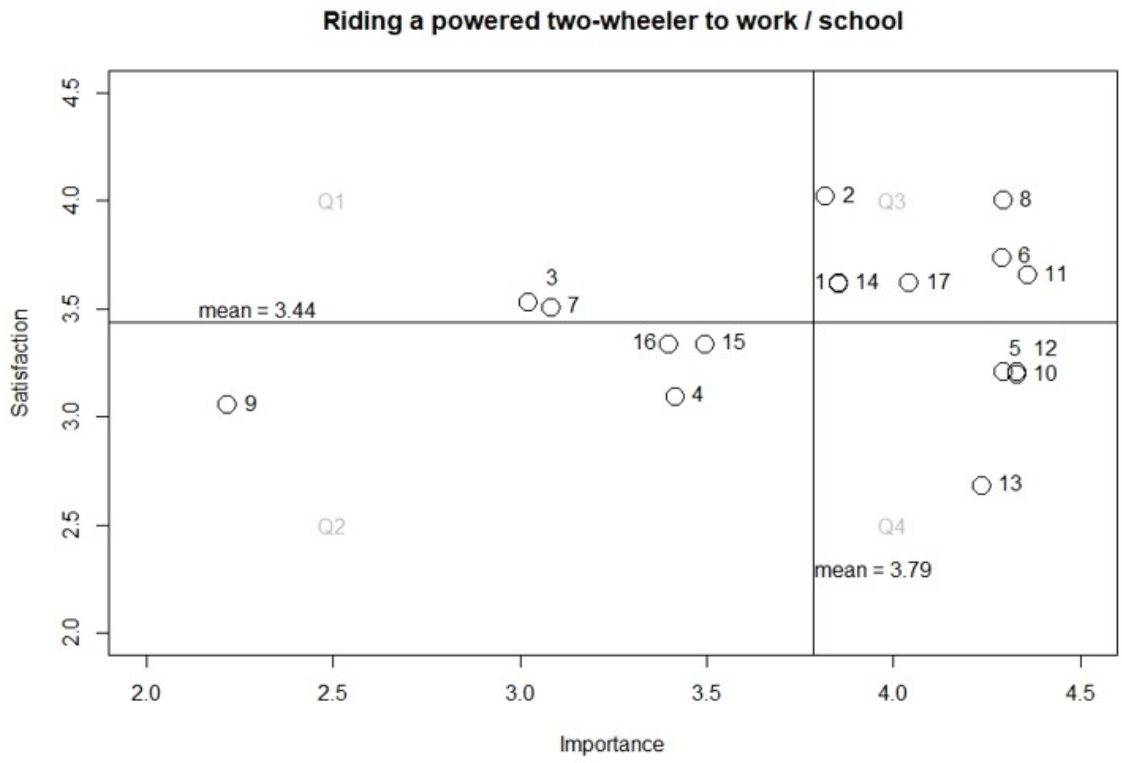

Figure 2. Results of JTBD "riding a powered two-wheeler to work / university / school"

can be transformed into real customer benefits and inform additional functionalities in the vehicle, wearables and/or human machine interfaces (information, smartphone application) and/or new (digital) services (possibly in cooperation with partners). The three identified fields for future innovation potentials and next R&D courses of action are:

- Addressing user needs to enhance personal safety with the new E-PTW
  - Enhancement of predictability, visibility and distance control to other road users
  - Display of real-time information about road and weather conditions

- Enhancing the E-PTW's accessibility with regard to handling the weight of an E-PTW (ages 50+)
  - Development of a lightweight E-PTW that can be handled without much strength

- Addressing user needs with regard to charging
  - Ensuring seamless modes of recharging at all spots during the time of travelling and/or in office
  - Formulation of new business models centered around new charging routines beyond charging stations, e.g., by possibly incorporating portable batteries

In response to these insights, the next step was translating these user needs into equivalent prototype designs which fulfil these requirements. Additionally, some user needs confirmed the study's existing research themes, e.g., the development of a lightweight vehicle design, which further solidified its importance during the innovation process. Additionally, in response to the

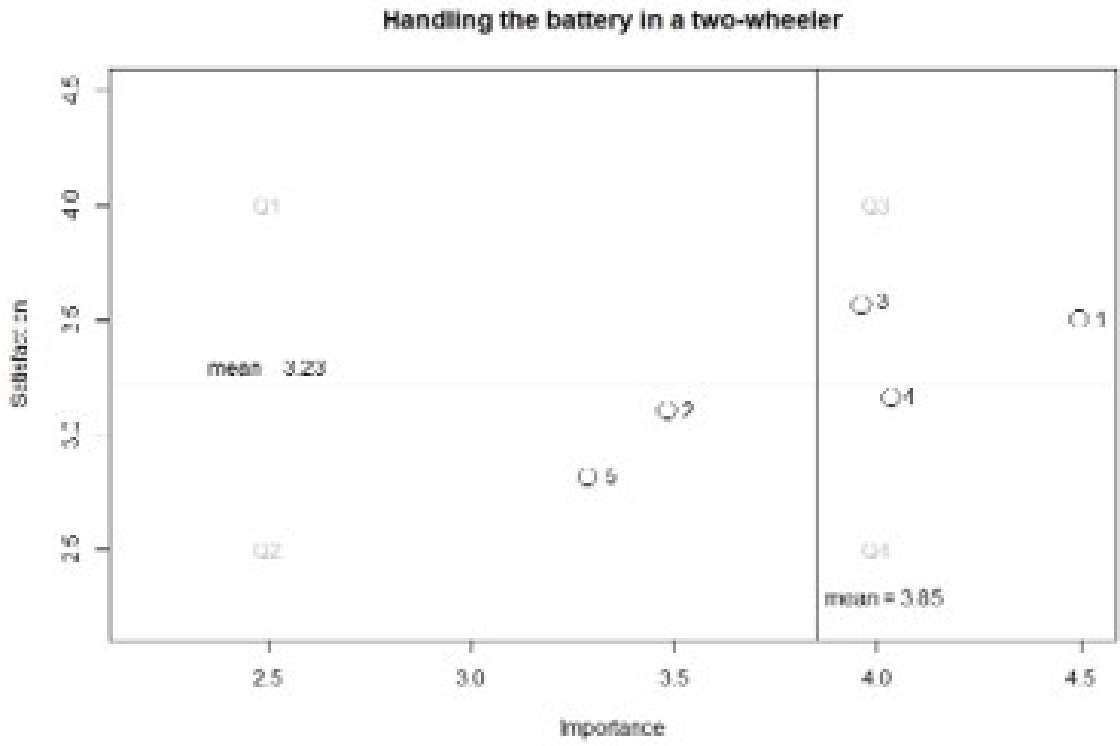

Figure 3. Results of the JTBD "handling the battery in a two-wheeler"

user needs of charging a battery without the presence of a charging station, this topic became prominent theme when researching innovative business models centered around commuting and charging routines. Lastly, the user needs with regard to ensuring driver safety and visibility have significantly influenced not only the vehicle design process, but also vehicle's trial phase.

Revisiting outcome-driven innovation's application for responsible innovation

Business managers are accountable for quantifying customer satisfaction and therefore are heavily reliant on feedback from (potential) customers – making the customer-needs collection process paramount. As described, making use of the outcome-driven innovation method as an inclusive and iterative process of generating value can make a meaningful contribution to enhance both the marketability and societal desirability of emerging e-mobility innovations. Responsible innovation, as stated out from Stilgoe et al. (2013), is a method of instilling deliberation upon societal matters throughout the course of the innovation process, in four dimensions: *anticipation, reflexivity, inclusion* and *responsiveness*. In doing so, matters of unpredictability, intentions, motivations, social and political organizations and future innovation orientations are addressed. This study's application of outcome-driven innovation was found to mainly answer some of these very questions and adhering to two of the responsible innovation dimensions in particular – *inclusion* by purposefully involving the wider public, and *responsiveness* by expressing openness to alter future product innovation based on the feedback gathered from the respondents in an iterative and receptive process. As the four dimensions of responsible innovation are reciprocal and interconnected to each other to form an integrated framework, it can be said that outcome-driven innovation's application has spillover effects into the other two dimensions, *anticipation* and *reflexivity*. Furthermore, outcome-driven innovation and responsible innovation's overlaps are

solidified as they both have applications at the project level, involving researchers, financers and other stakeholders. Additionally, outcome-driven innovation and responsible innovation advocate for a more bottom-up approach to innovation and changing power dynamics with regard to whose voices are heard in the innovation process, similarly with open innovation and user-driven innovation approaches. By assessing users' JTBD, responsible innovation's critical questions of intentions and motivations revisit the principle social dimensions of innovations. With that being said, outcome-driven innovation is capable of being ingrained in the context of a responsible innovation framework.

6 Practical implications & future outlook

The aim of this research is to make a meaningful contribution to innovation management's understanding of responsible, user-centered innovation of electric-powered two wheelers through the lens of outcome-driven innovation. By incorporating the customer's perspective of jobs to be done, electric mobility solutions can be developed that solve real user problems. Amidst a 'technology push' for electric mobility, users will be quicker to adopt a technology for reasons not only due to perceived societal desirability, but because it properly addresses their individual targeted requirements.

A possible limitation of our approach is that we delineated two JTBD for the purpose of the user survey. Although these JTBD and their statements provided rich insights of further innovation potentials, additional JTBD could be explored. This opportunity could serve the basis for possible further research concerning user perceptions of electric-powered two wheelers.

The following recommendations for future research were developed as a result of this project:

- Explore outcome-driven innovation's further application in the e-mobility space when conceiving new products and services to address questions of responsibility, possibly exploring different dimensions of responsible innovation
- Instigate the combination of other customer needs-focused approaches when aiming to design and develop societally responsible innovations from the outset

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8 Annex

Table 3. Results of statements for job to be done "Riding a powered two-wheeler to work / university / school" for all participants (mean values).

Statement	Importance	Satisfaction	Quadrant
1. When I ride my PTW to work or to school, I can store everything I need.	3,85	3,62	Q3
2. Mounting my PTW is easy, even with protective clothing.	3,82	4,02	Q3
3. Before a longer stop, I know in advance where to find a lighted, suitable parking spot for my bike.	3,02	3,53	Q1
4. I can use a navigation aid (e.g. smartphone) while riding without problems.	3,42	3,09	Q2
5. Slippery surfaces on the road (sand, leaves, etc.) are always clearly visible.	4,30	3,20	Q4
6. When riding around bends, I can always assess the necessary radius and lean angle of the PTW.	4,29	3,74	Q3
7. I ride as environmentally friendly as possible (i.e. economical fuel or battery consumption).	3,08	3,51	Q1
8. While riding, the dashboard of my PTW is clearly visible.	4,30	4,00	Q3
9. While riding, making calls is possible without difficulty.	2,22	3,05	Q2
10. The behaviour of other road users can be easily predicted.	4,33	3,20	Q4
11. Speed limits and traffic signs are clearly visible while riding.	4,36	3,65	Q3
12. On the PTW, I feel clearly visible to other road users.	4,33	3,20	Q4
13. Other road users maintain an appropriate distance from me.	4,24	2,68	Q4
14. The PTW can be moved into and out of parking spots without much strength.	3,85	3,61	Q3
15. At my most frequent destinations, I have a weatherproof shelter for my PTW.	3,50	3,34	Q2
16. If necessary, I can also transport things (e.g. groceries) with my PTW.	3,40	3,34	Q2
17. Even after a long day, concentration while riding my PTW is effortless.	4,04	3,62	Q3

Table 4. Results of statements for job to be done "Riding a powered two-wheeler to work / university / school" for female participants (mean values).

Statement	Importance	Satisfaction	Quadrant
1. When I ride my PTW to work or to school, I can store everything I need.	3,79	3,93	Q1
2. Mounting my PTW is easy, even with protective clothing.	4,03	4,21	Q3
3. Before a longer stop, I know in advance where to find a lighted, suitable parking spot for my bike.	3,00	3,39	Q2
4. I can use a navigation aid (e.g. smartphone) while riding without problems.	3,31	3,04	Q2
5. Slippery surfaces on the road (sand, leaves, etc.) are always clearly visible.	4,41	2,86	Q4
6. When riding around bends, I can always assess the necessary radius and lean angle of the PTW.	4,48	3,57	Q3
7. I ride as environmentally friendly as possible (i.e. economical fuel or battery consumption).	3,21	3,54	Q1
8. While riding, the dashboard of my PTW is clearly visible.	4,52	4,11	Q3
9. While riding, making calls is possible without difficulty.	2,00	3,32	Q2
10. The behaviour of other road users can be easily predicted.	4,52	3,04	Q4
11. Speed limits and traffic signs are clearly visible while riding.	4,55	3,50	Q3
12. On the PTW, I feel clearly visible to other road users.	4,45	3,14	Q4
13. Other road users maintain an appropriate distance from me.	4,45	2,75	Q4
14. The PTW can be moved into and out of parking spots without much strength.	4,03	3,71	Q3
15. At my most frequent destinations, I have a weatherproof shelter for my PTW.	3,52	2,96	Q2
16. If necessary, I can also transport things (e.g. groceries) with my PTW.	3,59	3,43	Q1
17. Even after a long day, concentration while riding my PTW is effortless.	4,21	3,54	Q3

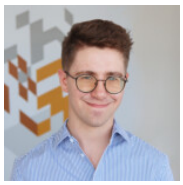
Table 5. Results of statements for job to be done "Riding a powered two-wheeler to work / university / school" for participants older than 50 years (mean values).

Statement	Importance	Satisfaction	Quadrant
1. When I ride my PTW to work or to school, I can store everything I need.	3,93	3,68	Q3
2. Mounting my PTW is easy, even with protective clothing.	3,85	3,90	Q3
3. Before a longer stop, I know in advance where to find a lighted, suitable parking spot for my bike.	3,04	3,62	Q1
4. I can use a navigation aid (e.g. smartphone) while riding without problems.	3,26	3,23	Q2
5. Slippery surfaces on the road (sand, leaves, etc.) are always clearly visible.	4,28	3,25	Q4
6. When riding around bends, I can always assess the necessary radius and lean angle of the PTW.	4,26	3,58	Q3
7. I ride as environmentally friendly as possible (i.e. economical fuel or battery consumption).	3,32	3,58	Q1
8. While riding, the dashboard of my PTW is clearly visible.	4,36	3,99	Q3
9. While riding, making calls is possible without difficulty.	2,07	2,91	Q2
10. The behaviour of other road users can be easily predicted.	4,38	3,22	Q4
11. Speed limits and traffic signs are clearly visible while riding.	4,36	3,75	Q3
12. On the PTW, I feel clearly visible to other road users.	4,38	3,20	Q4
13. Other road users maintain an appropriate distance from me.	4,30	2,75	Q4
14. The PTW can be moved into and out of parking spots without much strength.	3,91	3,40	Q4
15. At my most frequent destinations, I have a weatherproof shelter for my PTW.	3,57	3,46	Q1
16. If necessary, I can also transport things (e.g. groceries) with my PTW.	3,31	3,46	Q1
17. Even after a long day, concentration while riding my PTW is effortless.	4,11	3,63	Q3

Table 6. Results of statements for job to be done "Handling the battery in a two-wheeler" for all participants (mean values).

Statement	Importance	Satisfaction	Quadrant
1. I can charge and store the battery of my electric Two-Wheeler in my home or at work.	4,50	3,50	Q3
2. I am notified (e.g. on my smartphone) when the battery of my electric Two-Wheeler is fully charged.	3,48	3,10	Q2
3. I can remove the battery of my electric Two-Wheeler without exertion and carry it comfortably.	3,96	3,57	Q3
4. I can easily charge the battery of my electric Two-Wheeler on the road, even without a charging station (e.g. at a socket in a café).	4,02	3,16	Q4
5. I would like to receive personalised tips (e.g. on my smartphone) on how and when I can charge the battery of my electric Two-Wheeler the best.	3,29	2,81	Q2

Biographies



Michael Thelen. Michael Thelen is an innovation researcher at Salzburg Research. In his research, he investigates innovations in sustianable urban mobility and logistics from an innovation management perspective and a psychological lens of behaviour change. He undertakes multiple European-wide research projects with a focus on smart cities, sustainable mobility and sustainable consumer behavior. He holds a Master's Degree in Digital Communication, Policy and Innovation.

ORCID: https://orcid.org/0009-0008-8037-8519
CRediT Statement: writing – original draft, writing – review & editing

Veronika Hornung-Prähauser. Veronika Hornung-Prähauser, Head of Innovation Research at Salzburg Research. She is a graduate of the Vienna University of Economics and Business Administration and participant in the Executive Academy of MIT Sloane School with a research focus on early stage innovation management, open innovation, ecosystem and lead-user engagement methods. In numerous European and national research projects and studies in the fields of active mobility and health, she investigated the economic and social impact of information and communication technologies.

ORCID: https://orcid.org/0000-0002-4431-172X
CRediT Statement: conceptualization

Claudia Luger-Bazinger. Claudia Luger-Bazinger is a senior researcher at Salzburg Research. In her research, she explores digital behaviour change interventions for sustainable behaviour as well as user needs and technology acceptance of digital innovations enabled by the internet of behaviour. She works in multiple national and European-wide research projects and advises clients, with a focus on smart cities, sustainable mobility and health. She holds a PhD in psychology.

ORCID: https://orcid.org/0000-0003-0616-4228
CRediT Statement: formal analysis, investigation, visualization, writing – review & editing

Sebastian Will. Sebastian studied psychology at the University of Wuerzburg. Afterwards, he started to work at the Psychological Institute teaching Traffic Psychology. In parallel, he began working for the WIVW GmbH. He finished his PhD in 2017 with a thesis about presence enhancement in driving simulators. Sebastian's main research interest and expertise lies in the field of Human Factors and Cognitive Ergonomics. More precisely: human-machine interaction, driver behavior and training, Powered Two Wheeler research and simulators.

ORCID: https://orcid.org/0000-0003-0098-6212
CRediT Statement: project administration, supervision, writing – review & editing