THE QUANTIFICATION OF WORKAROUNDS AND WAYS TO UTILIZE THESE RAMIFICATIONS

by

Wayne Jacob Mario Hollman

A thesis submitted to the Department of Mechanical Engineering on May 16, 2011 in Partial Fulfillment of the Requirements for the Degree of Mechanical Engineering at the Massachusetts Institute of Technology

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Abstract

User innovation is steadily becoming an irreplaceable factor in product development. Thus it is necessary to find ways to measure these workarounds and ways to utilize these figures. I selected three (3) particular styles of workarounds to quantify and discuss. With makeshift window workarounds, I found that user workarounds in automobiles cost 84.9 times and households cost 67.9 less in magnitude compared to full repairs. Table adjustments workarounds were found to be many times greater than then replacing the table and the gap became greater with the increase in table price. Lastly examining medical instrument workarounds, I discovered that many these innovations can create profitable, niche markets. By using workarounds in general, producers can manufacture consumer desired products that generate revenue. In the future, I hypothesize that companies will lower their research and development funding in place of observing potentially, profitable workarounds.

Thesis Supervisor: Maria C. Yang
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LIST OF TERMS

GDP gross domestic product

Micro-scale. From a small perspective (e.i. individuals, private businesses)

Macro-scale. From a large perspective (e.i. nationally, gross population)

Product A good or service

User Firms or individual consumers that expect to benefit from *using* a product or a service

Workarounds. The name of a user innovation or producer innovation where a product is used not for its intended purposes

1. Introduction

Workarounds is a term that few know but many use. People call it "thinking outside of the box", "freestyling "Mickey Mouseing", and sometimes "fixing it up". The average person in the United States from the time when they wake up to the time when they sleep they experience or utilize various workarounds. From using a cup to scoop out sugar or a chair as a table to boarding up your window with plastic instead of glass are all workarounds. For the service of the article, workarounds can be defined as a product or service derived from any user innovation. User innovations come in many ways and styles from those that completely alter a product to those that only create a minute change in a product that affects a niche group. The magnitude of variation of workarounds is even greater than that of user innovations because the workaround could be the user innovation or the service that the user innovation provides. Throughout this article we will examine to a certain degree of depth the product aspect of workarounds.

In Section 2, Background, we will view the past of user innovations and producer innovations. User innovations exemplify workarounds that is used in households or for leisure that consumers usually develop out of need. Product innovations embody workarounds that is used in business sectors or for productions. Product innovations are most commonly the byproduct of efforts for efficiency. Theoretical Framework is Section 3 which highlights the approaches used to initiate findings and utilize them. This section clarifies the various experts view on it as well as justifies the type of calculations used. Section 4, Data Analysis of Selected Workarounds, gives the analytical view of each selected workaround. Each selected workaround will be analyzed on a micro-scale to view the various

affects they have on individuals. In Section 5, The Analysis of Workarounds Nationally, I will show the effects of workarounds on a macro-scale to illustrate the potential changes workarounds have to the economy. Section 6, Utilizing Workarounds, will use the data collected to show how the anticipating and manipulating workarounds can benefit individuals on a micro-scale and large corporation on a macro-scale. The monetary value of these decisions will also be illustrated in this section. In Section 7, Results, all of the data will be compiled to provide an overall understanding of the ramifications of the workarounds analyzed. Through this summary a clear view of the affects will be represented in the information. Section 8, Discussion, will reiterate the results from the data and clarify the magnitude of impact workarounds possess. Also this section will voice several possible future steps that will be helpful in steering society in its efforts to utilize workarounds. The goal of this work is to look into the realm of workarounds and provide a solution where users and producers can both benefit from a monetary standpoint.

2. Background

2.1. Inventiveness

Inventions come in various styles and locations but most fall under to distinct categories: invention and innovation. Throughout this article I will look thoroughly at the sectors of innovation. Innovations can be seen in office buildings, factories, and households in almost every area. The global spread of these innovative progress shows that new product development by consumers is much

more than a niche phenomenon (von Hippel, P.J. de Jong and Flowers 2010). The innovation in the business sector can be generalized into either producer innovation (Section 2.2) or User innovation (Section 2.3). Both concepts serve the same purpose of optimizing consumer satisfaction, but do so in very different methods.

2.2. Producer Innovation

Producer innovation, as described in this article, is the innovation efforts of a manufacturer. A manufacturer is an individual or firm selling a product to a consumer. For example, Motorola is a manufacturer of cell phones. If Motorola develops a phone that is able to take photographs and videos simultaneously because they believe consumers would buy them is an example of producer innovation. Motorola is choosing to use their resources and ingenuity to develop a new product that the company believes would increase consumer satisfaction. Because of the relatively larger satisfaction gained from using the new phone people would buy more phones which in turn increases profit.

2.3. User Innovation

User innovation, as described in this article, is the innovation efforts of a user. A user is an individual or firm that purchases a product from a manufacturer. A firm can be a user in some instances and a manufacturer in others. For example, Motorola who is a manufacturer of cell phones

is also a user of machines for circuits. Motorola purchase these machines and modify their constraints to manufacture Motorola-specific cell phones. These types of innovations have made impacts in the global product market.

User innovations have been an important component in the growth of the product market. Figure 1 illustrates this phenomenon. Development from users was shown to be most important with respect to both improved functionality over previous best practice and commercial value compared to manufacturers (von Hippel, P.J. de Jong and Flowers 2010). User firms develop most of the

Source	Innovation Area	Number and Type of Users samp	% developing innovations for personal use
1. Franke and Shah (2003)	Extreme Sporting	197 members of 4 specialized sporting clubs	32.1 %
2. Lüthje et al. (2005)	Mountain Biking	291 mountain bikers	19.2%
3. Tietz et al. (2005)	Kitesurfing	287 Australian Kitesurfers	28%
4. Franke et al. (2006)	Kitesurfing	456 Kite surfers	30.7

Table 1: Studies of Innovation Frequency among Consumers in Specialized Communities[1]

[1] Figure from von Hippel et al. 2010 (See References)

important innovations in the oil refinery industry (Enos 1962). On a study done by "von Hippel (1988) found that users were the developers of about 80 percent of the most important scientific instrument innovations, and also the developers of 67% of the major innovations in semiconductor processing" (von Hippel, P.J. de Jong and Flowers). The innovation of users is present in a wide range of industries and is high quality.

The technical quality of user innovations maybe seen as not that high but in actuality the quality of user innovation is no less than that of producer innovation. A particular study done by Lettl et al (2007) reviewed around 3000 patent families "in surgical instruments, devices or methods." Initially the citations for user innovations were lower than that of producer innovations which show the quality of the user modifications. Also the user modifications were in more classes than that of the producer innovations so the users incorporated a wider range of improvements. This shows that users in this industry have not only noticed more defects in the various products and service, but also made steps toward improving these defects. These users who choose to innovate are coined as "lead users" by von Hippel et al (2010). Von Hippel et al (2010) define these users as having two characteristics:

1) "Expecting major benefits from solutions to the novel needs they encounter"
2) "Being at the leading edge of important marketplace trends."

These characteristics define what is needed for user innovators to be successful in creating worthwhile products. The products that "lead users" choose to innovate are usually products that they use constantly and see defects in these products or the work that a "lead user" is doing needs a product that has more specific features. Since these lead users are also consumers the demand for these user innovated products are high. The increase in demand is due to the fact that there are fewer assumptions about what would increase consumer satisfaction because the "lead user" knows more about what is actually desired from the consumers. The study conducted by von Hippel (2005) shows that many innovations come about from "lead users" need for a product then producing it for other users to be able to use. There have also been studies in how the "lead user" goes from designing to commercializing their innovations. Most of these products become mainstream after they are adopted by other "lead users" and form user-companies. And only after the market is obtaining surplus revenue does producer-driven companies join into the newly formed market sector.

3. Theoretical Framework

3.1. Making User Workarounds Measureable

Since the idea of what user innovation is somewhat set, we can now look in to how can we examine the effects of these products. It is almost impossible to pinpoint the user workaround market because user innovation is done is almost every sector. In order to narrow down this broad market scope I will only examine select user workarounds. These workarounds must have several distinct criteria in so that these workarounds can be used to represent the entire market. These criteria are:

1) Must be applicable to all individuals of a similar socioeconomic status despite whatever other differences

2) Must be able to obtain profit within a market

3) Must be "common"

Each of these criteria is necessary for the selected workarounds in order to extrapolate the findings to a national scale. For the workaround to be applicable to the entire population is somewhat unrealistic because as monetary income changes so does the quality of the products those individuals buy. With these higher quality products less user innovation maybe needed. Though it the workaround is applicable to an entire socioeconomic status then I will be able to use the analyzed data to illustrate the effects on a macro-scale. By the workaround being applicable it would add validity to the fact that I will use the data analyzed on a macro-scale. The workaround also have to show that profit can be

gained from the adoption of these workarounds. This is necessary to add validity to the fact that workarounds affect the efficiency of resources used on products and the GDP of the nation (Section 5). Finally the selected workarounds must be "common" meaning that the workaround must be commonplace within society. For example, to move one's hands back and forth is known to mean hello. This gesture is "common" within most western nations. The selected workaround has to be "common" to add reliability to the analysis. Without this factor the data that I obtain would be useless.

3.2. Selection of Workarounds

Based off of the aforementioned criteria, I have decided to analysis three (3) distinct workaround categories: makeshift windows, table adjustments, and medical instrument workarounds. Makeshift windows (MW) workarounds have a strong connotation with lower-middle and low socioeconomic class individuals because of its wide spread use. Also this type of workaround is common within the United States (see examples in Figure 2). In most urban areas in the country one would be able to see a MW workaround on a vehicle or on a house. Because of this wide spread use many corporations incur a loss of profit from MW workarounds. The table adjustments (TA) workarounds were selected for similar reasons as the MW workarounds.

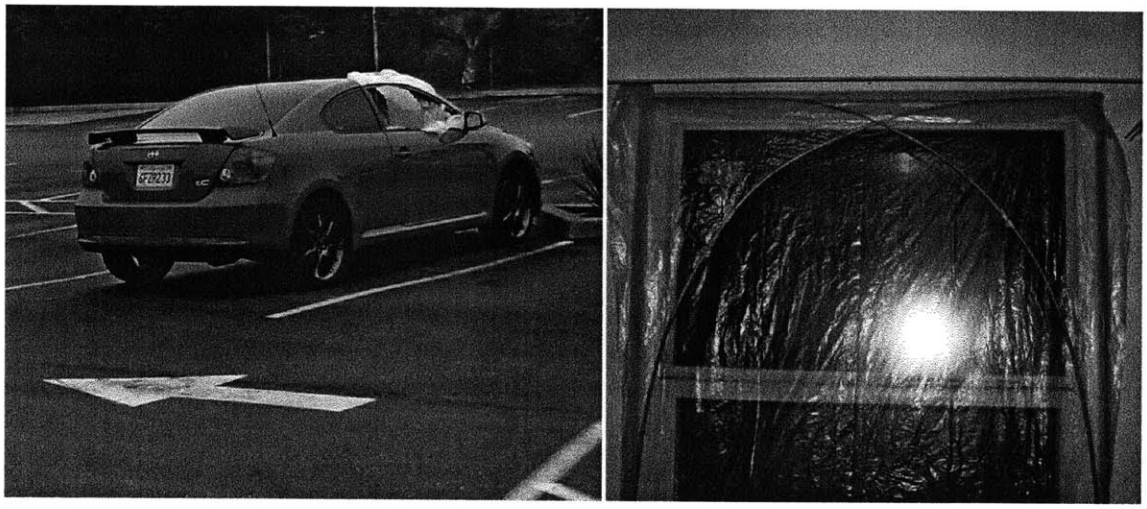

Figure 1: MW Workarounds: Car and House Examples

In many households across the nation one can find TA workarounds in the living area. Though they are somewhat "common" in hospitals and other medical facilities, medical instruments (MI) workarounds were mainly chosen for their profit-incurring potential. Many physicians either use or have need for many medical innovations but are too busy to implement or ask for them. MI workarounds have factors that will make countless producers enter the medical instrument industry.

4. Analysis of Selected Workarounds

In this analysis section I will use fairly, straight forward equation to develop the cost of each type of selected workaround and compare that cost to the cost of alternatives. The equation does not account for price fluctuation or competitor prices effect on the cost of materials. The developed equation is as follows:

Δ_{ω} = Cost of the Workaround

P_{ω} = Price of Workaround Material

Q_{ω} = Amount or Quantity of Workaround Material

W_{ω} = Average Wage per Hour

(Varies with Socioeconomic Class)

T = Time to Complete Workaround in Hours

Λ = Miscellaneous factor that is unique to each workaround

$$\Delta_{\omega} = (P_{\omega} \times Q_{\omega}) \pm (W_{\omega} \times T) + \Lambda$$

4.1. Makeshift Windows

MW workarounds come in many forms but I will lump them into two groups for convenience. The two groups of MW workarounds are automobile window repairs and household window repairs. These two groups encompass almost all of the MW workarounds.

4.1.1. Automobile Window Repairs

Automobile window repairs can possible comprise the largest amount of MW workarounds nationally. Many individuals use clear plastic to cover their window with and use duck tape to adhere it to the car's frame. This workaround is used instead of car replacements because of its relatively low cost. I will compare the price of a passenger side, front window replacement with that of a common user innovation which is plastic cover. These car window repairs can range from about $300 -$700 depending on the vehicle (Damewood 2011). I will use two common family sedans: 2010 Ford Taurus 4 door sedan, 2010 Honda Accord 4 door sedan. The prices of a window replacement for the 2010 Ford Taurus and 2010 Honda Accord are $353.95 and $281.95, respectively (2011). By taking the price of plastic to be $ 75.00 for 100 (23 3/8" by 32 1/8")[2] clear plastics bags, the price of duct tape to be $4.00 per roll (1.88" by 20 yd)[3], and the average income of a household in the U.S. ($52,029[4]), I will quantitatively compare the makeshift window workaround with the cost of repairs.

---

[2] Information obtained from source 2 (See Reference)

[3] Information obtained from source 12 (See References)

Ford Taurus Makeshift Window:

Window Dimensions[5] (Approximate): 20.2" by 42.27"

Perimeter of Window (Approximate): 124.94"

Average Time to Fix Window: 20 min

$$\Delta_{\omega} = [(\$75.00 \div 50^{6}) + (\$4.00 * \frac{124.94"}{20yd \times \frac{1yd}{3ft} \times \frac{1yd}{12"}})] + [(\$52{,}029 \div 365\ days \times \frac{1day}{24hours}) \times \frac{20min}{60min}] + 0^{7}$$

$$\Delta_{\omega} = [\$1.50 + \$0.69] + [\$1.98] + 0$$

Δ_{ω} = $4.17 for the 2010 Ford Taurus

Honda Accord Makeshift Window:

---

[4] Information obtained from source 15 (See References)

[5] Information obtained from source 19 (See References)

[6] Only 2 pieces of plastic is needed to cover window

[7] I am not taking into account the possibility of theft, heat loss, and other miscellaneous factors

Window Dimensions[8] (Approximate): 19.37" by 40.60"

Perimeter of Window (Approximate): 119.94"

Average Time to Fix Window: 20 min

$$\Delta_\omega = [(\$75.00 \div 50) + (\$4.00 * \frac{119.94"}{20yd \times \frac{1yd}{3ft} \times \frac{1yd}{12"}})] + [(\$52{,}029 \div 365\ days \times \frac{1day}{24hours}) \times \frac{20min}{60min}] + 0$$

$$\Delta_\omega = [\$1.50 + \$0.67] + [\$1.98] + 0$$

Δ_ω = $4.15 for the 2010 Honda Accord

As one can see the price to create a workaround as a MW for an automotive company is much less that the cost of repair. The cost to get a window replacement for a 2010 Ford Taurus was around $353.95 which is 84.9 times the $4.17 cost it takes make a MW. Also the $281.95 cost of a window replacement for a 2010 Honda Accor d is 67.9 times the cost of its $4.15 MW replacement.

[8] Information obtained from source 9 (See References)

4.1.2. Household Window Repairs

Another relatively common MW is replacing windows in one's home with the use of plastic. This is almost identical to the MW automotive repairs. Many individuals develop this workaround out of the need for a quick and simple fix to a window. We will compare a standard price for window replacement with the cost of a workaround. The price of replacement windows can range from $189 - $ 700 (eHow 2011). We will us the similar measurements as in the Automotive Window Repairs section to compare the cost of a workaround to the replacement.

Household Makeshift Window:

Window Dimensions[9] (Approximate): 36" by 48"

Perimeter of Window (Approximate): 168"

Average Time to Fix Window: 30 min

$$\Delta_{\omega} = [(\$75.00 \div 25^{10}) + (\$4.00 * \frac{168"}{20yd \times \frac{1yd}{3ft} \times \frac{1yd}{12"}})] + [(\$52{,}029 \div 365\ days \times \frac{1day}{24hours}) \times \frac{30min}{60min}] + 0$$

[9] Information obtained from source 20 (See References)

$$\Delta_{\omega} = [\$3.00 + \$0.93] + [\$2.97] + 0$$

Δ_{ω} = $6.90 for the Average Household Replacement

The cost to create a workaround as a MW for a home is much less that the cost to have a professional come in to install a new 36" by 48" window. The cost to get a window replacement for an average house window ranges from $189 to $700 which is 27.4 to 101 times the amount of a MW.

4.2. Table Adjustments

Wobbling tables is a reoccurring theme throughout the world. After repeated use, various sections of the table start to lose their straightness. Some might just get rid of the table, but others who may have a connection with the table or tough financial situation seek a different solution. From this TA workarounds are developed. TA workarounds a unique because most of the time the table's repair cost is more than the table so the best alternative is actually buying a new table. Also the workaround cost is relatively low because the items used for the workaround is normally unused items around the house. Below is the depiction of the quantitative cost of TA workarounds when a book or napkin/used paper are used. I will give the cost of a book the value of $ x.00 because books' value vary a great deal so I am going to leave the value $x.00 for

---

[10] Takes for clear plastic bags to cover

the analysis. The price of the napkin/used piece of paper will be $0.00 because the paper at that point is assumed to be trash which has a value of about $0.00.

Book Table Adjustment:

Cost of Used Book: $ x.00

Average Time to Adjust Table: 5 min

$$\Delta_{\omega} = [\$x.00] + [\,(\$52{,}029 \div \mathbf{365}\ \boldsymbol{days} \times \frac{\mathbf{1}\boldsymbol{day}}{\mathbf{24}\boldsymbol{hours}}) \times \frac{\mathbf{5}\boldsymbol{min}}{\mathbf{60}\boldsymbol{min}}] + 0^{11}$$

$$\Delta_{\omega} = [\$x.00] + [\$0.49] + 0$$

Δ_{ω} = $x.00 + $0.49 for a TA workaround using a book

Used Napkin/Paper Table Adjustment:

Cost of Used Napkin/Paper: $ 0.00

[11] I am not taking into account the possibility of the table breaking, book size, and other miscellaneous factors

Average Time to Adjust Table: 5 min

$$\Delta_{\omega} = [\$0.00] + [\,(\$52{,}029 \div \mathbf{365\ days} \times \frac{\mathbf{1day}}{\mathbf{24hours}}) \times \frac{\mathbf{5min}}{\mathbf{60min}}] + 0^{12}$$

$$\Delta_{\omega} = [\$0.00] + [\$0.49] + 0$$

Δ_{ω} = $0.49 for a TA workaround using a used napkin/paper

Though some of the values may not be clear, the benefits of TA workarounds are quite obvious. If one looks at the case of a $10.00 book and a $150.00 table the ratio of cost of replacement to workaround is almost 15 times greater. Considering this same table but through the used napkin/paper TA workaround perspective the ratio between replacement and TA workaround grows to 300 times greater. The benefit of using a TA workaround is clearly apparent.

4.3. Medical Innovations

User innovation in the medical industry was good and plenty. Most new products come from either producers viewing the workarounds that already occur in the medical industry or field

[12] I am not taking into account the possibility of the table breaking, book size, and other miscellaneous factors

discoveries. Eric von Hippel et al. discovered that many of the new discoveries in pharmacotherapy were field discoveries. "Of the 144 new uses identified for the 1998 new drug approvals, 84/144 (50%) were initially categorized as field discovery based upon simple inspection of the authorship and contents of the seminal article" (Eric von Hippel et al. 2006). The evidence here shows that user innovation is a key aspect in the growth of products in the medical industry. I will examine two components to the MI workaround industry which are Off Label Drug Use and Medical Instrumentations.

4.3.1. Off-Label Drug Use

The user discovery component of user innovation is a prime factor in off-label drug use. The research of Eric von Hippel et al. "found that 59% (85/144) of the drug therapy innovations in our sample were discovered by practicing clinicians via field discovery"(2011). This discovery exemplifies the importance and the impact of user innovations. Without field discoveries over 50% of the off-label drugs that become effective treatments to major illnesses would not have been discovered. This workaround is an influential component

4.3.2. Medical Instrumentation

Now switching to medical instruments an obvious workaround induced environment. Many doctors especially surgeons come across needs that many of their current instruments cannot

satisfy so they develop their own. For example, during surgery many surgeons do not possess a convenient place to set them surgical instruments they use. Some surgeons just place their instruments on the patients' bodies which can cause several hygienic and logistical issues. I will examine the cost of a surgeon developing a product to alleviate this need by developing a table. This table will be placed on the patient's stomach to provide a convenient place for the surgical instruments.

Surgical Table:

Average Salary of a Surgeon[13]: $302, 270

Cost of Antibacterial Plastic[14]: $26.69 by 31-1/2"W x 31-1/2"H x 31-1/2"D

(Surface Area[15] = 4,961.25 $in.^2$)

Surface Area of Table[16]: 77 $in.^2$

Average Time to Make: 40 min

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[13] Information obtained from source 14 (See References)

[14] Information obtained from source 13 (See References)

[15] The plastic has no top

[16] Determined by average length of surgical tools and average width of human body (See References)

$$\Delta_{\omega} = (\$26.69 \times \frac{77\ sq.\ in.}{4961.25\ sq.in.}\ ^{17}) + (\$302{,}270 \div 365\ days \times \frac{1day}{24hours}) \times \frac{40min}{60min} + 0$$

$$\Delta_{\omega} = (\$0.41) + (\$23.00) + 0$$

Δ_{ω} = $23.41 cost for the make of the table

Comparing this $23.41 price to the price of a surgery, many surgeons feel the table workaround is worth the cost.

5. The Analysis of Workarounds Nationally

5.1. Description of Findings

Going beyond the small scale view into a macroscopic perspective the effects of workarounds become more apparent. By looking at aggregate U.S. numbers, I was able to compare the workarounds to replacements of a macro-scale.

N = Aggregate National Number of Citizens in Category

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[17] Takes for clear plastic bags to cover

μ[18] = Percentage of Individuals of Category who use Workaround

$\boldsymbol{\theta}$ = National Cost of Workarounds

$$\boldsymbol{\theta} = \Delta_{\omega} \times \mu N$$

5.1.1. Makeshift Window

Aggregate Automobile Makeshift Window:

Number of Passenger automobiles in the U.S.[19]: 137,079,843

2010 Ford Taurus Makeshift Window: $4.17

2010 Honda Accord Makeshift Window: $4.15

$$\boldsymbol{\theta} = \left(\frac{\$4.15 + \$4.17}{2}\right) \times (.33 \times 137{,}079{,}843)$$

$\boldsymbol{\theta}$ = $ 188,183,208.47 if 33% of the sedans use makeshift windows

---

[18] For simplification we are going to assume μ is .33 throughout the paper

[19] Information obtained from Source 17 (See References)

$$\boldsymbol{Repairs}^{20} = \$\ 14{,}382{,}896{,}907.01 \text{ if 33\% of sedans needed window replacements}$$

$$\frac{\boldsymbol{Repairs}}{\boldsymbol{\theta}} = \frac{\$14{,}382{,}896{,}907.01}{\$188{,}183{,}208.47} = 76.4302$$

Aggregate Household Makeshift Window:

Number of Households in the U.S.[21]: 129,969,653

Household Makeshift Window: $6.90

$$\theta = (\$6.90) \times (.33 \times 129{,}969{,}653)$$

$$\boldsymbol{\theta} = \$\ 295{,}940{,}899.88 \text{ if 33\% of the households use some form of makeshift windows}$$

$$\boldsymbol{Repairs}^{22} = \$\ 19{,}064{,}598{,}550.31 \text{ if 33\% of the households obtained window repairs}$$

$$\frac{\boldsymbol{Repairs}}{\boldsymbol{\theta}} = \frac{\$\,19{,}064{,}598{,}550.31}{\$\,295{,}940{,}899.88} = 64.4203$$

---

[20] Used $353.95 and $281.95 as the cost of replacements

[21] Information obtained from Source 15 (See References)

[22] Used the average of $189 and $700 for window repairs

5.1.2. Table Adjustments

I used the number of households to represent the aggregate number of tables.

Aggregate Book Table Adjustment Makeshift Window:

Number of Households in the U.S.[23]: 129,969,653

Book Table Adjustment Workaround: $x.00

$$\theta = (\$x.00) \times (.33 \times 129{,}969{,}653)$$

θ = $ x.00 × 42,889,985 if 33% of the households use book adjustment workarounds

Repairs **= Cost of new table × 42,889,985 if 33% of the households obtained window repairs**

[23] Information obtained from source 15 (See References)

Aggregate Book Table Adjustment:

Number of Households in the U.S.[24]: 129,969,653

Used Napkins/Paper Table Adjustment: $0.49

$$\theta = (\$0.49) \times (.33 \times 129{,}969{,}653)$$

θ = $ 21,016,092.89 if 33% of the households use used napkin/paper adjustments

Repairs **= Cost of new table × 42,889,985 if 33% of the households obtained window repairs**

5.1.3. Medical Instruments

5.1.3.1. Medical Instrumentation

Aggregate Book Table Adjustment Makeshift Window:

Number of General Surgeon in the U.S.[25]: 19,791

[24] Information obtained from Source 7 (See References)

Surgeon Innovated Table: $23.41

$$\theta = (\$23.41) \times (.33 \times 19{,}791)$$

θ = $ 152,891.41 if 33% of the surgeons made a table

5.2. Summary

These measurements illustrate the vast potential of workarounds. Relating to MW repairs on a macro-scale, automotive MW workarounds are 76.43 times cheaper which is a difference of $14,194,713,698.54. Also there is $ 18,768,657,650.43 gap between the costs of repairs of household windows to the cost of MW workarounds from a national view. Though the figures are theoretical, they give a sense of the magnitude of difference of the cost of workarounds and the price of repairs. Similar to the MW workarounds, the TA workarounds have significant gap between the cost of workarounds and replacement. The table adjustments may vary with cost of book and table but that variation only creates a bigger gap in the costs. Lastly, the MI workarounds create a new niche market by utilizing the needs of a group with a product.

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[25] Information obtained from Source 19 (See References)

6. Conclusion

By quantifying workarounds I was able to effectively convey the potential effects of workarounds. As Figure 3 shows that the economically feasible choice is to use workarounds. MW workarounds seem from the large cost of repairs. On a micro-scale, the difference of $353.95 and $281.95 to $4.17 and $4.15 is too great for many consumers to overlook.

Workarounds	Micro-Scale	Macro-Scale
MW Workarounds – Sedan Car (Average of Two Cars)	**$4.16**	**$188,183,208.47**
MW Workarounds - Household	**$6.90**	**$295,940,899.88**
TA Workarounds - Book[26]	**$10.49**	**$449,915,942.65**
TA Workarounds – Used Napkin/Paper	**$0.49**	**$ 21,016,092.89**
MI Workarounds – Medical Instruments	**$23.41**	**$ 152,891.41**

Table 2: The Quantitative Representation of Workarounds on a Micro-Scale and Macro-Scale

[26] Assuming a book cost $10

For TA workarounds[27], the cost of a replacement is $100 and the cost of the workaround is between $10.49 and $0.49. Also MI workarounds, create a niche market which generates $23.41 per workaround. Nationally this can accumulate over $500,000[28]. There is clear quantifiable gain to producers utilizing workarounds. Solutions to may industry problems can be found from analyzing workarounds. Research and development (R&D) antics could be used to combat the loss of revenue from workarounds.

7. Discussion

By viewing the workarounds the way workarounds can benefit companies are quite obvious.

7.1. Application

Workarounds are not just bound by the fields and industries I mentioned before. There are workarounds in office spaces and in extreme sports. A group of snowboarders modify their snowboards to be able to grind on particular high mountains (von Hippel et al., 2010). By modifying their board they are able to create a new niche market of snowboards. Also many oil refineries have makeshift procedures and tools that are produced for when needed. This action within itself calls for more flexible tools within the oil industry.

---

[27] Assuming a book cost $10 and a table cost $100

[28] Assuming 33% of surgeons use it

User innovation is common among many industries so the producer benefit is also very prevalent. A workaround tells producers that there is a need not being met because the consumer makes attempts at fulfilling that need. If producers spend more resources on observing and quantifying workarounds, they would be able to capture the revenue that workarounds gain for the companies of the materials that are used. It is also possible to charge more than the cost of material and labor because of the companies association to the product.

7.2. Profitability

The scales of the workarounds demonstrate the possible profit that a producer can gain by utilizing these user innovations. The potential profit is vividly illustrated in MW workarounds because with 33% of their respective industry would cost $ 188,183,208.47 for sedan-style automobiles and $295,940,899.88 for households. By spending more capital on to research ways to negate these MW workarounds, companies such as Ford and Honda could gain large returns with relatively low cost. "In 2007, the total amount of cosmetic plastic surgery costs added up to $12.4 billion, as reported by the American Society of Plastic Surgeons" (Surgery.com 2009). The cost of surgery is so much greater than the cost to make the surgical table that surgeons would be willing to buy the table to decrease the risk of mishap. Also the convenience that workarounds such as the surgical table create is desired by consumers. The consumer does most of the research for producers by developing solutions for

product issues. By mimicking these workarounds, producers would be able to gain positive profit from their product add-ons.

7.3. Future Steps

With consumer innovation becoming a prominent factor in most the current market, future corporations' R&D will utilize this data. For example, if a table is unbalanced at a high end restaurant, the restaurant would rather buy a completely new table instead of risking the embarrassment of a TA workaround such as a napkin. By knowing this is a possibility, manufacturing companies could have a table leg replacement and instructions on how to fix it with the purchase of the table. Though this would cost more, consumers would be willing to pay this because it would be less than the cost of a full replacement.

Workarounds make it feasible for companies to spend less money on experiments and surveys which make assumptions on what consumers need and get direct feedback by examining workarounds that arise in the field. Having direct feedback cuts out assumptions and provides credible evidence of what consumers want which is profitable. User innovation creates a tangible bridge from consumers' and their desires to producers'. Workarounds can be the way to increase the efficiency of the resources used by making consumer desires clear.

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Appendix

Source	Innovation Area	Number and Type of Users samp	% developing innovations for personal use
1. Franke and Shah (2003)	Extreme Sporting	197 members of 4 specialized sporting clubs	32.1 %
2. Lüthje et al. (2005)	Mountain Biking	291 mountain bikers	19.2%
3. Tietz et al. (2005)	Kitesurfing	287 Australian Kitesurfers	28%
4. Franke et al. (2006)	Kitesurfing	456 Kite surfers	30.7

Table 1: Studies of Innovation Frequency among Consumers in Specialized Communities

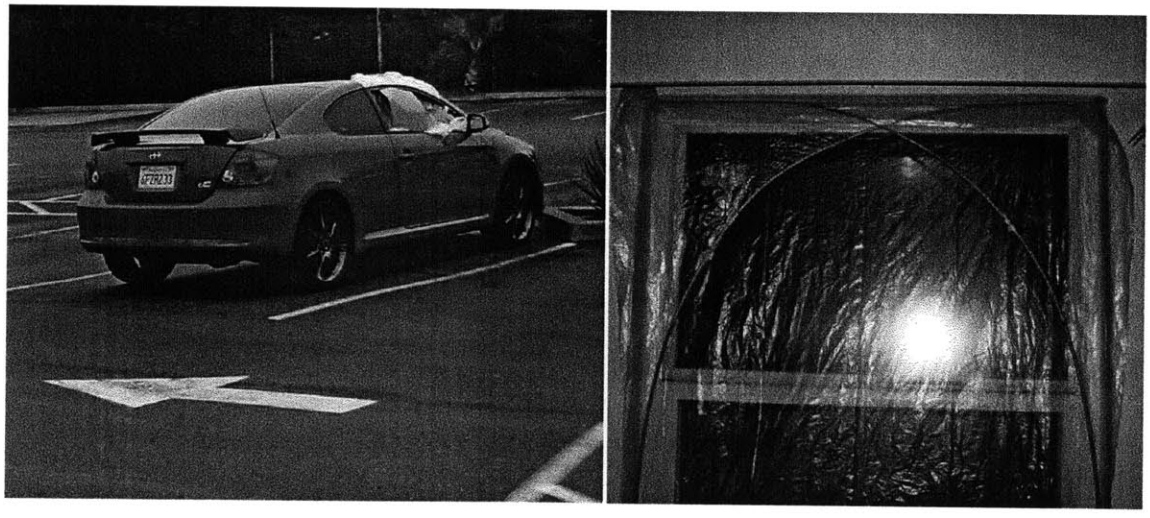

Figure 1: MW Workarounds: Car and House Examples

Workarounds	Micro-Scale	Macro-Scale
MW Workarounds – Sedan Car (Average of Two Cars)	$4.16	$188,183,208.47
MW Workarounds - Household	$6.90	$295,940,899.88
TA Workarounds - Book[29]	$10.49	$449,915,942.65
TA Workarounds – Used Napkin/Paper	$0.49	$ 21,016,092.89
MI Workarounds – Medical Instruments	$23.41	$ 152,891.41

Table 2: The Quantitative Representation of Workarounds on a Micro-Scale and Macro-Scale

[29] Assuming a book cost $10