مركز محمد بن راشد
للابتكار الحكومي
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FOR GOVERNMENT INNOVATION

UAE HOUSEHOLD SECTOR INNOVATION

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Summary and Key Recommendations

There is a significant level of household level innovation (around 5% of the population) occurring in the UAE, which to date has been unaccounted for.

Targeted policies can ensure that the country makes the most of this untapped potential, by:

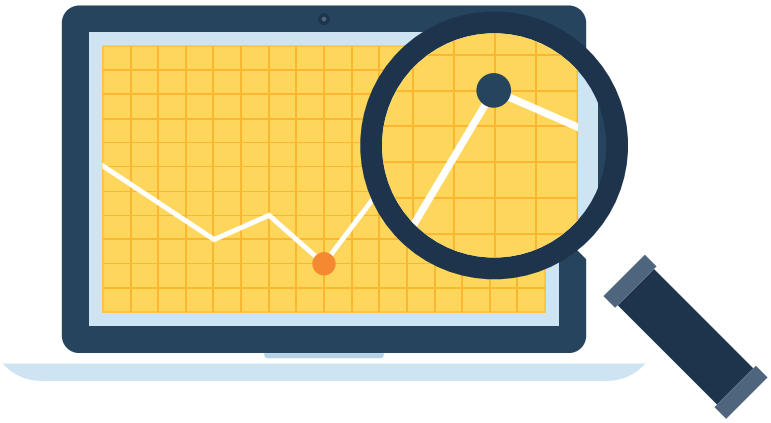
- Tackling **current bottlenecks** (e.g. lack of innovation diffusion)
- Creating **platforms for household innovators** to connect (based on the survey results, students could be a primary target)
- **Measuring** household innovation at regular intervals (this would allow to measure the impact of interventions and could help in raising the UAE global innovation rankings as international institutions progressively embrace the household innovation paradigm)

Developing a comprehensive **policy** to support household innovation would give the UAE a leading position in an emerging field, provide it with a competitive advantage and position it as a powerful advocate for rethinking innovation measurement globally.

In addition, the results of the UAE survey also seem to suggest that improving the level of household innovation diffusion could have a positive impact on citizens' happiness and overall welfare.

Key findings from the UAE survey

- Household sector innovation is about those innovations that are developed at private cost by individuals during their unpaid discretionary time – no one pays them to do it. This is quite a departure from the traditional innovation paradigm, which is predicated on producer innovation (i.e. private sector companies). For this reason, household level innovation has traditionally been neglected and has been, so to speak, "invisible" for the purposes of innovation measurements and rankings.
- In the United Arab Emirates, around **5 percent** of all consumers aged 18 and older innovated in the past three years. This represents around 465,000 citizens – a considerable source of innovation that has so far been unreported. This percentage is in line with other countries where this type of innovation has been measured to date (including Japan, South Korea, Finland, Canada, UK and the US).



- UAE household innovators are more likely to innovate if they are well-educated, technically trained, and at the higher end of the income distribution. **Men** and **women** are equally likely to be household innovators. **Students** are very likely to innovate in their leisure time. Moreover, having access to the internet is associated with HHS innovation. From a policy perspective, the link between education and household innovation is worth further investigation. Activities targeting at stimulating household innovation could well be served by focusing on students to begin with.
- Household sector (HHS) innovators are usually motivated by **personal needs** (45% of all innovators) or process benefits like fun and learning (33%). Very few are primarily driven by commercial motives (4%). This again represents a significant difference with the traditional innovation paradigm, which assumes that commercial profit is the main driver for innovation. Important implications follow for both innovation and social policy.
- Household level innovations report more frequent innovations in the following sectors: **computer software, household items and education**
- HHS innovators spend considerable time (average 4.61 days) and money (AED 5,121) on their innovations. One way of looking at this is as **R&D that is freely available**, distributed but currently unaccounted for. UAE HHS innovations are generally not protected with intellectual property rights, and potentially freely available to all.

- About one out of five HHS innovations diffuses to other people. The main diffusion mechanism is peer-to-peer diffusion (16%). HHS innovators themselves estimate that about 44% of their innovations would be valuable to some or nearly all other people if diffused to them. This implies that the government could play a major role in boosting innovation and increasing overall welfare by encouraging platforms for diffusion of HHS innovations.
- HHS innovators are highly willing to share their innovations. Contrary to perception, the majority would do this for free. However, as in other countries, the diffusion effort actually exerted by HHS innovators is relatively modest. Only 30% make any effort to inform other potential individual adopters. Efforts related to inducing supplier adoption and initiating diffusion via entrepreneurship are done even less often.
- HHS innovators are much more likely to be involved with early-stage **entrepreneurship** than are non-innovating individuals, although not all of this activity is related to the HHS innovation they report upon in the survey: 26% have a startup or are nascent entrepreneurs. HHS innovators seem to be proactive individuals. This seems to suggest that there are opportunities to improve entrepreneurship in the country by supporting their efforts.
- Finally, HHS innovators are **happier** people compared to non-innovators, especially if they see their innovations diffuse to others.
- Altogether, we see a major potential for the UAE to develop policies to stimulate HHS innovation and diffusion.

HHS innovators are HAPPIER people compared to non-innovators, especially if they see their innovations diffuse to others.

INTRODUCTION

Motivation: UAE's National Innovation Strategy

His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, launched the National Innovation Strategy on October 2014 that aims to make the UAE among the most innovative nations in the world. The Mohammed Bin Rashid Centre for Government Innovation (MBRCGI) supports entities across the UAE's Federal Government to deliver the strategy. One of the key pillars of the National Innovation Strategy is individual citizens and enhancing their innovation and entrepreneurship potential. The Centre has funded a survey to better understand household sector innovation in the UAE.

Household sector innovation can inform national innovation strategies

Consumers have been shown to be a major source of innovation. They innovate at private cost during their unpaid discretionary time – no one pays them to do it; and they do not protect their design with intellectual property rights. As a consequence, their designs are potentially acquirable by anyone for free. Consumers may innovate for several reasons. Often, they are motivated by a personal need for the innovation. In addition, they may be motivated by personal rewards obtained from the innovation process itself such as fun, a desire to learn, and a desire to help others (von Hippel, 2017).

National innovation strategies are often still oriented towards research and development in the academic or private sectors. Policy adjustments are clearly needed, because recent research points to the potential positive impact of household innovation on welfare and markets alike. It has been shown that new industries can emerge out of household sector innovations. Also, household innovators enhance social welfare by developing cheaper or better substitutes to commercial products (e.g., Linux open-source software) and complements which increase the value of existing products (e.g., individuals developing modules to computer games).

Nationally representative surveys have shown that many individual consumers innovate. So far, surveys have been done in the UK, Netherlands, USA, Japan, Finland, Canada, South-Korea and Sweden. At the population level, millions of consumers across the globe can be considered innovators. Consumer innovators invest time and money to solve problems in their everyday lives – typically a few person-days and a couple of hundreds of dirhams. Collectively, however, their investment is huge. Their total expenditures are similar in scale to consumer product development expenditures made by commercial enterprises.

Objective: map and benchmark household sector innovation

Given the prior research findings on the importance of household sector innovation summarized above, the objectives of the UAE survey we report upon here have been:

A. To quantify the percentage of household sector innovators in the UAE

B. To explore the antecedents of household sector innovation

C. To measure the propensity of household innovators to diffuse their knowledge

D. To benchmark household sector innovation with other countries

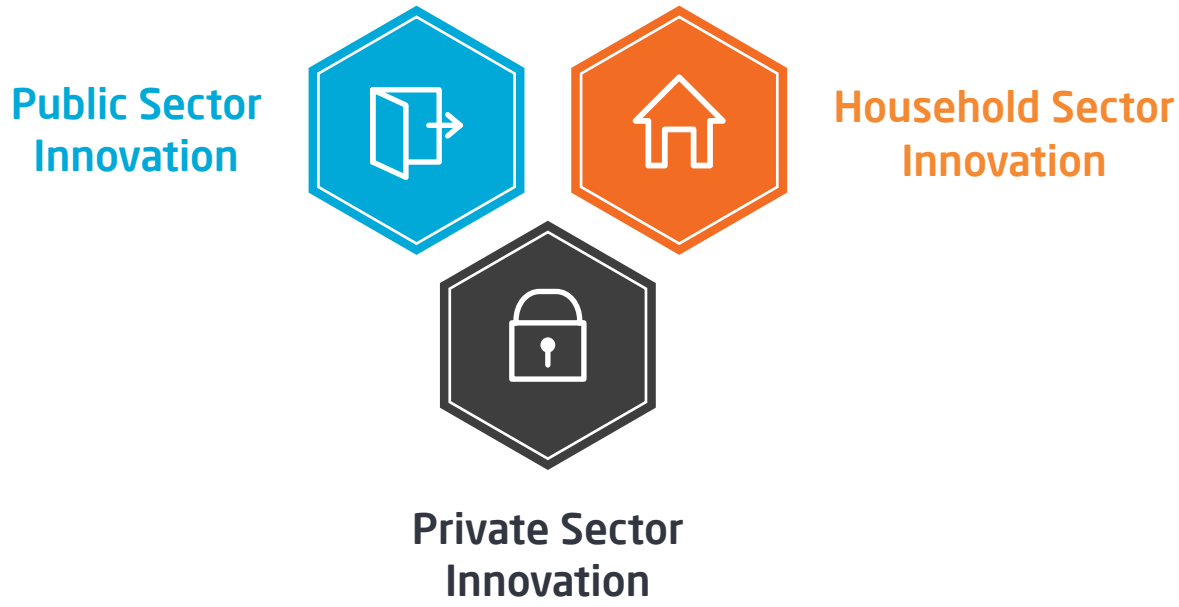
The survey results presented in this report may inform the development of a national innovation strategy with regard to household sector innovators.

HOUSEHOLD SECTOR INNOVATION

Innovation is not only the domain of commercial businesses

It is not long ago that policy makers started to realize that beyond businesses, innovations can also be developed by public sector organizations and even in the household sector (figure 1).

Figure 1. Innovation activity in economic system includes private, public and household sector innovation



The mainstream view of policy makers in many nations is that innovation is the domain of commercial producers. Producers benefit from innovative efforts only if others adopt/buy their innovations. This view implies that innovations originate from businesses and are supplied to consumers via products that are introduced to a market for sale. Over the years, this producer-centered model has strongly influenced policy practices. Examples include innovation policies which stimulate producers to engage in innovation activities marked by uncertain market demand - legitimizing intellectual property rights, R&D subsidies, tax credits, and facilities for public-private partnerships.

Consumers innovate as well: free innovations

In the past ten years it has been shown that individual end consumers also innovate, typically for non-economic reasons: to satisfy their personal needs, for fun, to learn or develop new skills or competences, or to help others fixing particular problems. Empirical evidence shows that hundreds of millions of consumers annually spend hundreds of billions of dollars developing and modifying products across the world. Driven by the ever-increasing quality of design and communication tools, including the Internet, 3D printing and CAD/CAM tools, and improvement education standards, innovation by consumers is expected to become more important in the future. It is an important complement to innovation in commercial organizations, and sometimes an effective substitute for it (von Hippel, 2017).

Free innovations are developed by individual end consumers motivated by non-economic motives, including personal need, fun, learning or helping others. Free innovation exists when: (1) innovations are developed at private cost by individuals during their unpaid discretionary time – no one pays them to do it; and (2), innovation designs are not actively protected by the developer – they are potentially acquirable by anyone for free (von Hippel, 2017).

Why consumers innovate

In practice, many consumers do not find precisely what they need on existing markets. Meta-analyses of market-segmentation studies suggest that individual needs for products are highly heterogeneous (Franke & Reisinger, 2003). Incumbent producers tend to follow product development strategies to meet the needs of homogenous market segments (Cooper, 2003). Being motivated to sell sufficiently large numbers to recoup their innovation investment, they end up leaving many consumers slightly or strongly dissatisfied with their offerings. Moreover, consumers are typically first to pilot with new products which do not yet exist (Shah & Tripsas, 2007). Incumbent producers get interested only later when sufficient numbers of consumers want the emerging product type – historical examples include airplanes, whirlpools, dishwashers, kitesurfing equipment, mountain bikes and juvenile products, to mention only a few.

Recent work shows that beyond personal need, consumers innovate for other reasons – partly related to the benefits derived from participating in the innovation process. Consumers may innovate simply because they enjoy the act of innovation, to learn or develop new skills, or to help others. In contrast, innovating for commercial reasons is rare (Raasch & von Hippel, 2013). The development and diffusion of innovations motivated by these broader, participation-related benefits strongly resembles with those observed for consumer innovations for personal needs, and are similarly distinct from commercially-motivated innovations (von Hippel, 2017).

Diffusion of household sector innovations often fails

Compared to business innovation, an important distinction is how user innovations diffuse to other economic actors. Businesses will sell their innovation to consumers and/or firms. Simultaneously, their knowledge can spill over to other innovators and adopters. To the extent that user innovations are generally valuable diffusion should occur too, or consumers with similar needs would need to exercise a similar innovation effort. In general, user innovations may spread directly to peers (users freely reveal their innovations to others), be transferred to producers (adopting user innovations to further improve and sell them as commercial products) or be diffused in new ventures (users starting a business to commercialize their innovation) (de Jong & von Hippel, 2013).

"There is therefore an important role for improved government innovation policies that will both stimulate household sector innovation, and ensure that generally valuable consumer-developed innovations diffuse so that others can benefit."

However, in practice many household sector innovations with high general use value fail to diffuse. As consumer innovators lack incentives and are not concerned with the value that others would obtain from adopting their innovation, they fail to invest in the diffusion effort that would be optimal from a social welfare perspective (de Jong et al., 2015).

HOUSEHOLD INNOVATION IN THE UNITED ARAB EMIRATES

Around 5 percent of the UAE consumers are household sector innovators

Drawing on our survey data we estimated that in the population of UAE consumers of 18 years and older, 4.9 percent are household sector innovators. Household sector innovators are defined as those who have developed at least one new item during the past 3 years with functional novelty. We also required that they must have developed it in their free time, and not for their job, business or employer.

Assuming 9.5 million citizens aged 18 and over, this is the equivalent of 465,000 consumers. We feel that this is a substantial number. It has never been visible before this survey, because innovation by individual consumers is not-at-all recorded in official surveys.

Table 1 provides other relevant population estimates.

Table 1. Key statistics regarding household sector innovation (n=2095)

TYPE	DESCRIPTION	ESTIMATED FREQUENCY	95% CONFIDENCE INTERVAL	NUMBER OF CITIZENS
Household Sector Developer	Includes innovations and homebuilt- versions of existing products	8.5%	[7.3% - 9.7%]	807,000
Household sector innovator	Includes innovations with functional novelty	4.9%	[3.9% - 5.9%]	465,000
Free innovator	not protected with intellectual property rights	4.7%	[3.7% - 5.7%]	446,000
User innovator	fully or partially motivated by personal need	3.0%	[2.2% - 3.8%]	285,000

Developers is the most inclusive category (estimated frequency among UAE consumers is 8.5%.) This category is intended to capture all "tinkering and making" activity among consumers in the UAE. In addition to household sector innovators, it includes those who report tinkering with objects in their households, and also those who report creating homebuilt versions of existing products. (Non-innovators in the developer category may be consumers most easily convertible to household sector innovators by appropriate governmental policy changes.)

Free innovators (4.7%) are consumers who develop functionally novel products, but do not protect their innovations with intellectual property rights – they are willing to give their designs away.

User innovators (3.0%) include only those HHS innovators who have innovated for personal need.

Until very recently studies of HHS innovation only measured innovation by individual consumers that was motivated by personal need – what is called "user innovation."

Table 2 gives an overview how the incidence rate of user innovation in the household sector compares to other countries. For the UAE the incidence rate is at the lower side of the spectrum. We later explain that this result actually may be a function of the unusual demographic profile of the country.

For the consumers that are similar to those in countries in the benchmark (highly educated, higher income, etc.) the frequency of innovation actually is similar in the UAE. However, the UAE has many expatriates. Many of these have a lower education level and a relatively low income. They also have long work weeks, so that no time remains to engage in innovation.

Table 2. Frequency of user innovation in the household sector

SOURCE	COUNTRY	YEAR	FREQUENCY
von Hippel et. al (2012)	United-Kingdom	2009	6.1%
de Jong (2011)	Netherlands	2010	6.2%
Ogawa & Pongtanalert (2011)	USA	2010	5.2%
Ogawa & Pongtanalert (2011)	Japan	2011	3.7%
Kuusisto et al. (2013b)	Finland	2012	5.4%
De Jong (2013)	Canada	2013	5.6%
Kim (2015)	South-Korea	2014	1.5%
Fursov & Thurner (2016)	Russia	2014	9.6%
Harhoff (2016)	Germany	2016	8.2%
Bengtsson (2016)	Sweden	2016	7.3%
This study	United Arab Emirates	2017	3.0%

Kind of innovations: many household and children/educated-related items

Table 3 displays the types of products that UAE consumers have developed. As can be seen, compared to other countries, relatively more UAE innovations are related to **computer software**, to **household fixtures** and furniture, and to **children and education**-related issues.

Table 3. Objects of HHS innovation in three countries

OBJECT	UAE	FINLAND	CANADA
	(n=125)	(n=176)	(n=539)
Computer software	17%	6%	11%
Household items	29%	20%	19%
Transport or vehicle	10%	11%	10%
Tools or equipment	7%	20%	22%
Sports, hobby, entertainment	5%	17%	18%
Children, education	23%	4%	10%
Medical, health	2%	7%	8%
Any other product/application	7%	15%	3%
	100%	**100%**	**100%**

Examples of HHS innovations in the UAE

To get a flavor of the kind of items that UAE citizens have innovated in the past three years, we list a few examples:

TYPE	EXAMPLE
Help, care and medical	I hold camels and created a medicine for drying inflammation in the pores of my camels' heads. It cleans the pores and it is made of natural products.
Household fixtures and furnishing	A device to detect the validity/expiry date of food products, to provide detailed nutrition information. Analysis through laser. Not available on the market and facilitates food storing.
Transport and vehicle-related	A car engine with a design different from all current engine systems. Fuel efficient and easy to repair, and the number of engine parts is much lower than regular engine parts.
Tools and equipment	It is a cooling device for the car. The temperature is very high so I have improved the cooling system. Gives a better degree of cooling and balance in the car's electricity.
Children and education-related	App to keep track of my children when they go to school. Enables to locate them, and see if they are not playing games.
Other product or application	A special drink for diabetics. It includes a sugar substitute. The taste is different and the sugar is natural and healthy.
Sports, hobby, entertainment	I created a device to bring on acrylic nails. It makes it easier.
Household fixtures and furnishing	Created a funny penholder by recycling waste materials. Pens are upside down, keep them horizontally.
Medical, health	Improved a water filter to prevent health problems in the body I am very sensitive to polluted water; needed it myself.
Household fixtures and furnishing	Modified fitness device; no need to use my hands, have been injured.
Sports, hobby, entertainment	A better speed meter for bicycle wheels. Usually speed meter is connected to a bicycle wheel spoke and can fall off. My version cannot.

DEMOGRAPICS: WHO INNOVATES?

High education and technical background matter, gender does not

A common finding in previous surveys was that the frequency of innovation by consumers is higher for males, for those with high educational attainment, and for those with a technical training or job (von Hippel, Ogawa & de Jong 2011). In UAE we found a different pattern. Again, the cross-country benchmark can be done only for user innovation in the household sector. See Table 4.

Table 4. Frequency of user innovation for selected demographic groups, across countries

INCIDENCE RATE	UK (n=1173)	USA (n=1992)	JAPAN (n=2000)	FINLAND (n=993)	CANADA (n=2021)	UAE (n=2095)
General frequency of user innovation	6.1%	5.2%	3.7%	5.4%	5.6%	3.0%
Highly educated (at least bachelor degree)	8.7%	8.9%	3.7%	7.7%	6.5%	3.5%
Technical job or work experience	12.0%	8.0%	4.2%	8.8%	9.9%	4.5%
Male	8.6%	5.9%	4.9%	6.3%	8.8%	3.1%

Males in the UAE seem not to be more likely to be user innovators; a deviation from the common pattern. We suspect that, again, the demographic profile of UAE citizens can explain this (see hereafter).

The overall effect of being either highly educated or having a technical job/work experience is visible in the UAE data, but has a lower impact in the UAE relative to other countries. Education and training reflect personal capabilities for innovation: highly educated are more likely capable of developing fixes for their personal problems. For the same reason, it is likely that technical training matters for people's ability to develop solutions for the problems that they face. Such people probably have better access to solution information so that they can help themselves.

Detailed demographic differences

Table 5 provides an overview of the differences in HHS innovation frequency for various groups of consumers. For most of the reported variables the differences are significant. The table confirms that educational attainment matters for HHS innovation, as does being technically trained, and having technical work experience (e.g., as an engineer, construction worker, scientist, or whatever).

Table 5. Demographic profile of HHS innovators in the UAE

VARIABLE	GROUP	FREQUENCY	SIGNIFICANCE
General	All citizens aged 18 and older	4.9%	
Gender	male	5.2%	n.s.
	female	4.8%	
Education	primary school or less	3.0%	*
	secondary/tertiary school	4.4%	
	bachelor's degree	6.5%	
	master's / Phd degree	7.0%	
Technical training/education	no	4.3%	*
	yes	6.4%	
Technical work experience	no	3.9%	**
	yes	7.3%	
Employment	employed	4.4%	***
	self-employed/business owner	6.3%	
	student	17.4%	
	retired	13.6%	
	unpaid caregiver or homemaker	2.9%	
	unemployed	2.3%	
	other	5.4%	
Age	18 - 24	6.0%	n.s.
	25 - 34	4.8%	
	35 - 44	4.2%	
	45 - 54	6.2%	
	55 or older	3.8%	
Housing	private housing	5.8%	*
	collective housing	3.1%	
	other type of housing	3.7%	
Income (AED)	No personal income	5.2%	***
	1 to 999 AED	0.0%	
	1000 to 2499 AED	3.3%	
	2500 to 4999 AED	4.2%	
	5000 to 9999 AED	5.9%	
	10000 to 19999 AED	5.0%	
	20000 or more AED per month	6.7%	
Labor contract	Permanent contract	4.3%	***
	Limited contract, at least one year	5.8%	
	Limited contract, less than one year	0.0%	
Expected stay	< two years	2.5%	n.s.
	wo to five years	3.8%	
	five years or more	4.7%	

VARIABLE	GROUP	FREQUENCY	SIGNIFICANCE
Emirate	Abu Dhabi	5.2%	n.s.
	Dubai	6.9%	
	Sharjah	6.2%	
	Northern emirates	5.0%	
Nationality	Emirati	5.8%	n.s.
	Arab expat	4.2%	
	Western expat	9.4%	
	Asian expat	4.4%	
	Other	8.1%	
Internet access in free time	barely or not at all	1.2%	**
	parttime	4.2%	
	fulltime	6.3%	

Notes: Significant at * 5%, ** 1%, *** 0.1% level.

Students – very likely to innovate

The table shows that **students** are much more likely than others to be concerned with HHS innovation. Most of them, we assume, have the time to innovate and by tapping on their school's infrastructure, have the resources to innovate

Prosperous consumers more likely to be innovators

For the first time in household innovation surveys, the UAE survey measures the **impact of income**. We find consumers at the high end of the income distribution are more likely to innovate in their leisure time. In contrast, at the lower end of the income distribution the odds of HHS innovation are close to zero. Our finding regarding income also matches with consumers' access to the Internet. Without Internet access the frequency diminishes. We speculate this resembles with a lack of resources and that this deprives consumers from access to solution knowledge and tools available on the Internet. Likewise, if consumers live in collective households innovation is less likely, probably also reflecting a prosperity effect.

Why innovate if you are leaving the country?

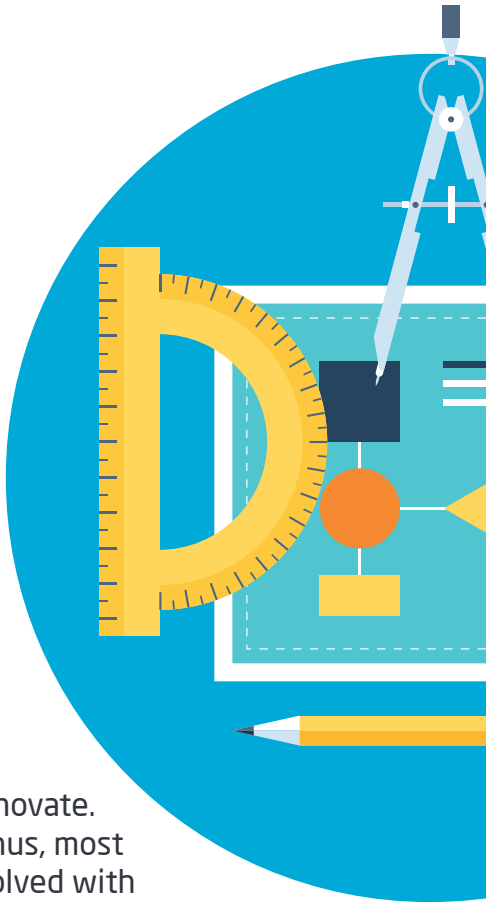
Another finding is that if consumers do not have permanent work contracts or expect to stay in the UAE only a brief time, innovation becomes less likely. This makes sense, as it is generally not attractive to invest in innovations if one expects their situation to change.

Westerners and Emirati – more likely to innovate

Overall, we find that Western expats and Emirati themselves innovate relatively often. In contrast, for Asian and Arab expats the odds seem relatively low. Western expats and Emirati are usually at higher incomes, well educated, and working on permanent contracts.

MOTIVES AND INNOVATION PROCESS

Why innovate, and how? This chapter first deals with the motives of HHS innovators, then explains innovation process variables including collaboration, investments and innovation protection.



Motives

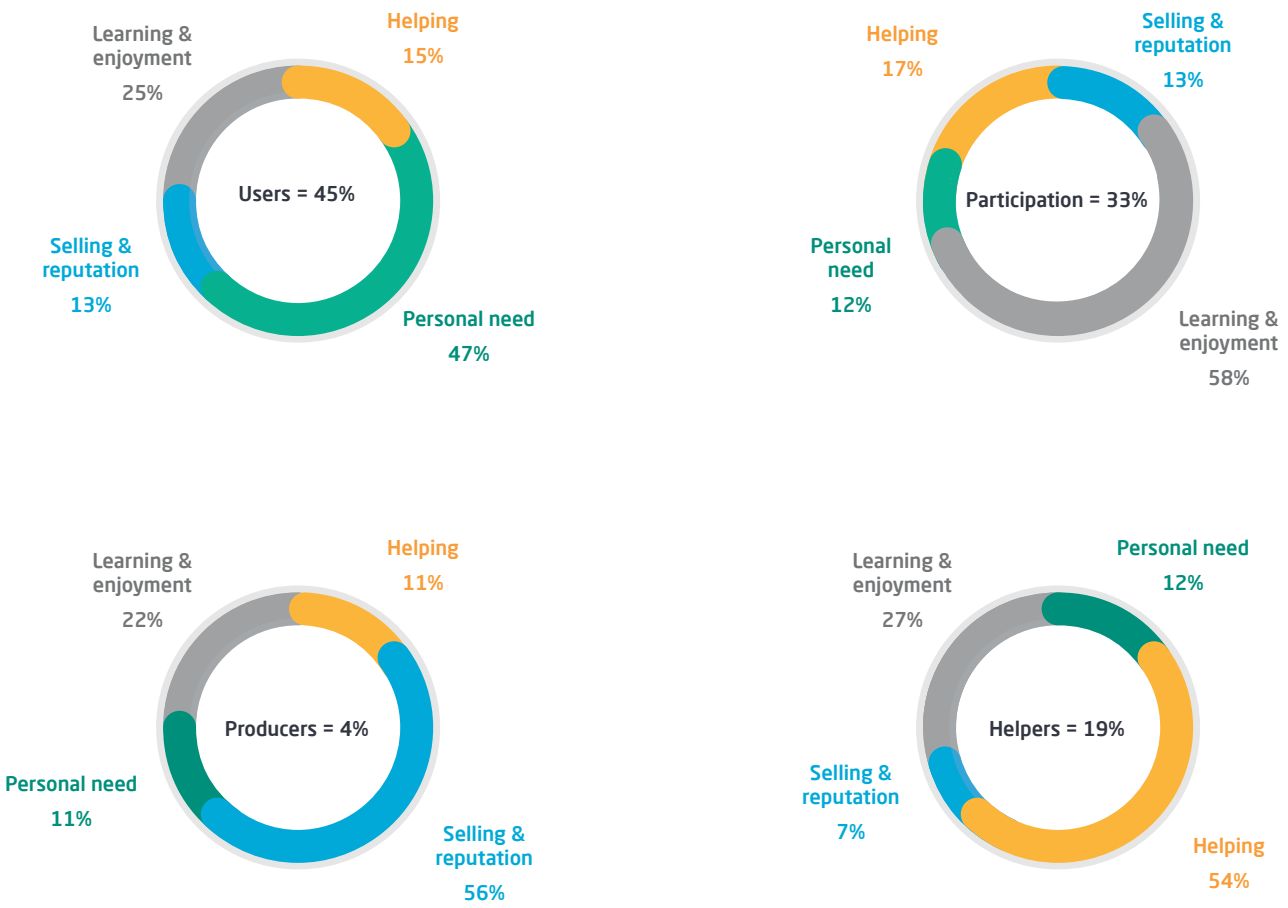
Consumer innovate for many reasons: personal need, helping other people, enjoyment, learning, reputation/recognition, or willingness to commercialize their innovation. While solving the problem that they face, opportunity to commercialize their innovation may already quickly come to their mind - not as a primary driver, but rather as an additional spur (Shah & Tripsas 2007).

Table 6 shows that on average, UAE consumers report 2.1 motives to innovate. When asked for their most important motive, personal need is on top. Thus, most innovations are developed to fix a personal problem that could not be solved with commercial offerings at hand. In contrast very few innovations were developed because consumers want to sell, or advance their reputation.

Table 6. Motives of UAE consumers to innovate

MOTIVATE TO INNOVATE	FREQUENCY	MOST IMPORTANT MOTIVE
Personal need	58%	45%
Helping	45%	19%
Learning	41%	19%
Enjoyment	36%	14%
Selling	6%	2%
Reputation/recognition	23%	2%

Figure 2. Four groups of HHS innovators according to their motives



Most HHS innovators are driven by personal need or process benefits

We clustered all HHS innovators in our sample into four groups, corresponding with their key motives to innovate. See Figure 2. For Users, the main innovation motive is personal need (47% of all motives that they reported to us). For Participators, the most important motive is learning and/or enjoyment (58% of all motives reported to us).

Altogether Users and Participators make up 78% of the population of HHS innovators in the UAE. Another 19% is primarily motivated by a willingness to help other people in their environment.

Only 4% of the HHS innovators are driven by commercial considerations. In this group we can expect most businesses to be started.

From a policy perspective these findings are important because they point to a potential priority for intervention. When people innovate for personal need, or to learn or for fun, they lack incentives to diffuse their innovations so that others cannot benefit. Policymakers can play a major role in fixing this gap.

Innovation Process

Individual vs. collaborative household sector innovation

In all countries surveyed to date, the great majority of household sector innovators develop their projects on their own, without the help of others. In the UAE, the survey indicates that innovation collaboration is more common than in other countries - in fact, the percentage of collaborations is right up there with the world leader to date, Finland (Table 7). Looking at the 26% that innovated with others, most collaborated with family and friends (18%) followed by collaborators at work (7%). This is a valuable pattern for UAE policymakers to build upon: Innovations developed collaboratively are known to be more generally valuable, and also more frequently diffused (de Jong et al. 2015).

Table 7. Share of household sector innovations develop in collaboration with other people

SOURCE	COUNTRY	YEAR	SAMPLE	FREQUENCY
von Hippel et al. (2012)	United Kingdom	2009	104 innovations	10%
Ogawa & Pongtanalert (2011)	USA	2010	114 innovations	11%
Ogawa & Pongtanalert (2011)	Japan	2011	83 innovations	8%
Kuusisto et al. (2013)	Finland	2012	176 innovations	28%
De Jong (2013)	Canada	2013	539 innovations	17%
This study	United Arab Emirates	2017	125 innovations	26%

Substantial investment is done

Household innovators in the UAE dedicate considerable amounts of (leisure) time and money in order to innovate. On average, they spent **4.61 person-days** to develop their most recent innovation, and **AED 5,121 out-of-pocket costs**. The distribution of these time and money expenditures is widely dispersed, a result that was also found in other countries. (See Table 8).

Table 8. Time and money investment in HHS innovations

	MEAN	MINIMUM	MEDIAN	MAXIMUM
Time spent on most recent innovation (in days)	4.61	0.06	1.38	62.5
Money spent on most recent innovation (in AED)	5121	0	100	250000

HHS innovations are very seldom protected with intellectual property rights

Commercial businesses will generally protect their innovation-related knowledge with intellectual property rights (IPRs) to exclude others and/or to facilitate licensing strategies. In contrast, HHS innovators are not triggered by direct economic benefits, and accordingly less inclined to attempt to exclude others from adopting their knowledge via intellectual property rights. Very few have used IPRs (Table 9). Effectively, HHS innovation resembles with what von Hippel (2017) labels as 'free innovation', that is, nearly all HHS innovations are potentially freely available to all other citizens.

Table 9. Frequency of protection of HHS innovation with intellectual property rights

SOURCE	COUNTRY	YEAR	SAMPLE	FREQUENCY
von Hippel et al. (2012)	United Kingdom	2009	104 innovations	2%
Ogawa & Pongtanalert (2011)	USA	2010	114 innovations	9%
Ogawa & Pongtanalert (2011)	Japan	2011	83 innovations	0%
Kuusisto et al. (2013)	Finland	2012	176 innovations	5%
De Jong (2013)	Canada	2013	539 innovations	3%
This study	United Arab Emirates	2017	125 innovations	4%

DIFFUSION

In this chapter we are first concerned with the diffusion of HHS innovations. Next, we present statistics regarding the extent to which HHS innovators put effort into diffusion.

Diffusion

Provided that HHS innovations are generally valuable, lack of diffusion implies a loss in terms of general welfare. In the absence of diffusion, every other consumer who could benefit from the innovation has to "reinvent" the same thing; a poor use of resources. Moreover, only a fraction of consumers facing a particular need will be able to develop their own solution – as most consumers lack the competences and resources to innovate for themselves.

One out of five HHS innovations is adopted by others

In the UAE, approximately 21 percent of the reported HHS innovations did spread to other economic actors, whereas 79% did not diffuse at all. This diffusion rate is comparable with Finland and Canada (Table 10).

Table 10. Types of diffusion of HHS innovations

TYPE OF DIFFUSION	FINLAND (n=176)	CANADA (n=539)	UNITED ARAB EMIRATES (n=125)
Of any kind	19%	21%	21%
Entrepreneurship	2%	0%	5%
Transfer to suppliers	6%	2%	2%
Peer-to-peer	16%	20%	16%

Peer-to-peer diffusion is the most common diffusion mechanism

HHS innovations can diffuse in any or all of three ways (de Jong & von Hippel, 2013):

- **To peers:** Users may reveal their innovations to others for inspection, copying and adoption without charge, so that innovations diffuse peer-to-peer. Table 10 shows that this is the most common diffusion mechanism in all investigated countries.
- **Supplier adoption:** Commercial suppliers may adopt HHS innovations to improve and sell them as commercial products.
- **New venture creation:** Innovating consumers may start a new business to introduce a commercial version of their innovation to the market.

From a policy maker's point of view, the first mode of diffusion (peer-to-peer diffusion) should be very interesting. When innovations spread freely among peers, the market mechanism is not involved. Not only that, especially in the case of emerging industries, large peer-to-peer diffusion rates have a considerable impact on economic growth and employment creation. In the UAE, peer-to-peer sharing is typically done with relatives and friends of the innovator. In addition, sharing may also take place between members of club or community in which the innovator belongs.

Venture creation by HHS innovators and supplier adoption both represent commercial modes of diffusion. These types of diffusion are relatively rare, but they do enable diffusion to broader society, as commercialization makes the innovation widely available on markets. The total share of innovations that are diffused commercially are relatively similar in comparison to other countries. Notably, however, in the UAE, a larger fraction, the commercially diffused innovations is done by new ventures instead of established firms. New ventures are valuable to societies. Diffusion of consumer innovations via the founding of new ventures is a promising pattern the UAE policymakers may wish to support.

Diffusion rate matches with most other countries

In Table 11 a benchmark is provided with other countries: the share of HHS innovations that diffused peer-to-peer, and/or was adopted by commercial suppliers. The UAE's diffusion rate is in line with the UK, Finland and Canada, and is better than that of the USA and Japan.

Table 11. Share of HHS innovations adopted by other users or firms across countries

SOURCE	COUNTRY	YEAR	SAMPLE	FREQUENCY
von Hippel et al. (2012)	United Kingdom	2009	104 innovations	17%
Ogawa & Pongtanalert (2011)	USA	2010	114 innovations	6%
Ogawa & Pongtanalert (2011)	Japan	2011	83 innovations	5%
Kuusisto et al. (2013)	Finland	2012	176 innovations	19%
De Jong (2013)	Canada	2013	539 innovations	21%
This study	United Arab Emirates	2017	125 innovations	18%

Effort to diffuse

Estimated 44% of the HHS innovations are deemed valuable to some or all other people

In the survey, we asked the innovator to estimate if s/he considered the innovation as valuable to others. Specifically, we asked if the innovation (1) would be useful to others (2) can be a viable product (3) addresses a problem experience by other people. Drawing on these indicators, the dataset can be clustered into three groups: innovations which are perceived to be valuable to no-one but the innovator (56%), to some others (33%), and to many others (11%). (See Table 12.)

Our rough estimate is that is about 44% of the HHS innovations is valuable to other people than the innovator. Thus, the diffusion rate of HHS innovations (21%, see Table 10) could usefully be increased.

Table 12. Perceived general value of HHS innovations

	MY INNOVATION...		
General value to:	...is useful to many or nearly all others:	...can be a viable product to an average-or mass-market:	...addresses a problem experienced by many/ nearly all:
No or Few others (=56%)	29%	13%	8%
Some others (=33%)	88%	69%	50%
Nearly all others (=11%)	100%	100%	100%

Interestingly, UAE innovators would rather share than sell

An important first criterion for diffusion is that innovating consumers must be willing to reveal their innovation-related knowledge to others. Table 13 indicates to what extent HHS innovators in the UAE report to be willing to share their innovations: for free, and for some kind of compensation (e.g., money, license fee, future favors or discounts, etc).

Table 13. Willingness to share or sell

VARIABLE/VALUE	FINLAND (N=176)	CANADA (N=539)	UAE (N=125)
Willingness to share for free			
no	16%	12%	16%
yes, selectively	40%	22%	39%
yes, with everyone	44%	66%	45%
Willingness to share for compensation			
no	9%	13%	37%
yes, selectively	23%	16%	33%
yes, with everyone	68%	71%	30%

In line with our presuppositions, we found that a large majority of the HHS innovators in the UAE have a positive attitude towards revealing their innovation. Very interestingly, we also found that UAE innovators are reluctant to accept compensation. Eighty-four percent of them (39% + 45%) are positive about free revealing, and only 63% (33% + 30%) are willing to share for compensation. Follow-up analysis shows that this difference is strongest for Asian expats, but also present for Emirati and Arab expats. The finding is in contradiction with Finland and Canada where it was found that willingness to share would increase with compensation.

Effort to inform other people in line with other countries

Being highly willing to diffuse does not imply that HHS innovators actually invest effort in attempting to diffuse their innovations. Table 14 shows that 30% do exert at least some effort to inform people, so that innovations can spread peer-to-peer. The diffusion effort is better than in the USA and Japan, and comparable with the other countries that have been investigated.

Table 14. Diffusion effort done by HHS innovators in various countries

SOURCE	COUNTRY	YEAR	SAMPLE	FREQUENCY
von Hippel et al. (2012)	United Kingdom	2009	104 innovations	29%
Ogawa & Pongtanalert (2011)	USA	2010	114 innovations	18%
Ogawa & Pongtanalert (2011)	Japan	2011	83 innovations	11%
Kuusisto et al. (2013)	Finland	2012	176 innovations	27%
De Jong (2013)	Canada	2013	539 innovations	34%
This study	United Arab Emirates	2017	125 innovations	30%

The diffusion effort is modest

Table 15 shows that beyond informing others, few innovators put effort into commercial diffusion. Eleven percent has contacted a commercial supplier to see if they were interested, and 7% explored if their innovation represented an entrepreneurial opportunity.

Table 15. Diffusion Effort by household sector innovators

TYPE OF EFFORT	PERCENTAGE	NO. OF ACTIVITIES (MIN = 0, MAX=4)*	ACTIVITIES DONE
Inform other people (peer-to-peer)	30%	0.36	share on request (17%), proactive demo (13%), Internet posting (4%), develop to ease adoption (2%)
Contact a business (transfer to producers)	11%	0.14	share on request (6%), proactive demo (5%), invest money to demonstrate (2%), develop to ease adoption (2%)
Commercialize yourself (entrepreneurship)	7%	0.10	explore demand (4%), explore IP (1%), explore how to startup (3%), develop to increase odds (2%)

* Respondents could report up to four diffusion activities

HHS innovation is associated with early-stage entrepreneurship

The Global Entrepreneurship Monitor (Bosma et al, 2012) measures to what extent citizens in a country are established business owners, or involved with setting up a business of their own. We collected data on the entrepreneurship indicators outlined in Table 16: (a) the share of established business owners, (b) the share of citizens involved in a startup (business founded, owner receives a salary for at least three months but not more than 42 months), (c) the share of citizens involved with nascent entrepreneurship (expecting to be a full or partial owner, no salary received for over three months, and having actively work on the emerging business in the past 12 months).

Table 16. Comparison of HHS innovators and other citizens on entrepreneurship indicators

ENTREPRENEURSHIP INDICATOR	HOUSEHOLD SECTOR INNOVATORS	OTHER CITIZENS	SIGNIFICANCE
Established business owner (a)	3%	3%	n.s.
Startup/baby business (b)	8%	3%	**
Nascent entrepreneurship (c)	19%	10%	**
Total entrepreneurial activity (b + c)	26%	13%	***

Notes: Significant at * 5%, ** 1%, *** 0.1% level.

Our analysis shows that **HHS sector innovators are more likely to be involved with a startup (8% of all HHS innovators) or in the process of setting up a new business (19%)**. We stress that this does NOT imply that HHS innovations are frequently commercialized via this route. Rather, Table 16 suggests that HHS innovators are likely to be proactive individuals taking charge of their life and future. These are personal traits that are also determinants of early-stage entrepreneurship. To us it seems there is entrepreneurship potential among HHS innovators.

CONSUMER HAPPINESS

HHS innovators are happier than non-innovators, especially if their innovations diffuse

Finally, we explored if household sector innovators are happier individuals than others. In summary, our findings suggest that the answer is 'yes'. When asked to indicate their personal life satisfaction on a ten-point scale, respondents gave a 7.7 on average. The subsample of household sector innovators gave a 7.9. See Table 17.

Especially when innovators observed that their innovation was adopted by others, their happiness score was boosted.

Table 17. Reported personal happiness of UAE citizens and HHS innovators

	HAPPINESS SCORE (MIN = 1, MAX =10)
All UAE citizens	7.7
Household sector innovators	7.9
HHS innovators; any diffusion observed	8.6
HHS innovators; diffused to peers	8.6
HHS innovators; diffused to supplier firms or in a new venture	8.6

No matter how the innovation diffused, on average the reported score was 8.6 (significantly higher at the 0.1% level). Beyond economic arguments to develop policies to stimulate HHS innovation and its diffusion, the personal happiness of UAE citizens will likely also improve with such policies.

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