



Third party ancillary revenues in the airline sector: An exploratory study

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ABSTRACT

Some airlines, especially Low Cost Carriers (LCCs), have earned significant profits from revenues derived from ancillary revenues. However, to date few have been able to derive a meaningful portion of revenues from 3rd party ancillaries. The key to increasing these revenues comes from an understanding of passenger willingness to pay for 3rd party products/services, coupled with increasing customer awareness and consequently the all-important customer conversion. This study assesses the 3rd party ancillary services that passengers are more willing to purchase, along with the potential offers that might increase their willingness to purchase specific 3rd party services. A mixed methods approach was used consisting of a passenger survey and nine expert interviews. The main findings are that car hire, airport parking, and the sale of hotel rooms had the most significant associations with customer willingness to pay. It was also found that there was a significant association between specific offers and increased willingness to purchase. The 15% discount off a future flight, and to a lesser extent, hotel price guarantees were the most significant. Expert interviewees confirmed that the future sustainability of this revenue stream for airlines is centred on mobile digital devices, customer conversion, and exploiting potential market opportunities.

1. Introduction

In 2017, the average return fare, according to the IATA was US\$351 or 63% below 1995 levels. Aligned to this the average cost of air freight was \$1.48 per kilogram, a 68% fall on 1995 levels. Two years earlier in 2015, the airline industry as a whole achieved a milestone. It was the first time ever that the industry generated a return on investment greater than the cost of capital (IATA, 2017). In real terms, airlines made \$35.3 billion net profit on revenues of \$718 billion or a return of 4.8%. These two developments highlight the growing importance of ancillary revenues for airlines worldwide. With base fares in free fall in real terms, the industry increasingly has had to rely on the sale of supplementary services to compensate. When the impact of global pandemics like Covid-19, fluctuating oil prices, flat lining cargo revenues and regional disparities in financial performance are factored in, the ability to generate significant interest and willingness to pay in ancillary products will become all the more critical for the world's airlines.

This study seeks to explore the future of the hitherto comparatively untapped 3rd party ancillary revenue stream from two perspectives; firstly from a passenger willingness to pay point of view and secondly from an industry viewpoint; the key themes that will affect the generation of 3rd party ancillary revenues in the years to come. The specific research questions to be answered are:

- What are the current prevalent themes in the area of 3rd party ancillary revenues in the airline sector?
- Is there is a significant association between 3rd party ancillary revenue type and willingness to purchase, for both long haul and short haul passengers and between type of offer and willingness to pay for specific 3rd party ancillary revenue products?

As well as being a relatively untapped ancillary revenue stream for many of the world's airlines, 3rd party products and services have also received very little attention in the academic literature thereby

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increasing the need for a research study that explores this revenue stream from a passenger and supplier perspective.

The paper will be broken down as follows: Section 2 and 3 deal with the historical development of airline ancillary revenues and the mainly industry based literature on 3rd party services specifically, section 4 examines the mainly non-academic literature on 3rd party willingness of pay and customer conversion. Section 5 details the study's mixed methods approach while sections 6 and 7 present and discuss the main results and interpret findings. Section 8 draws conclusions and managerial implications.

2. Airline ancillary revenues

Ancillary revenues have become an increasingly important part of overall airline revenues. The increase in ancillary revenues over the last 10 years has seen airlines expand their traditional revenue footprint by unbundling the traditional airline fare and charging for services that were once included within the fare (Warnock-Smith et al. 2015). This unbundling was encouraged by the fact that airlines found passengers to be less price sensitive when it comes to ancillary fees, compared to the price sensitivity of the fare itself (Wilson 2014). This realization has led to a greater focus on ancillary revenues as a proportion of overall revenue. The top ten ancillary revenue airlines in 2018 had ancillary revenues per passenger ranging from, Spirit at US\$51 to Hawaiian at US\$33; this is compared to the top ten in 2008 ranging from, Spirit at US\$19 to American at US\$20, as shown in Table 1. This represents a large average increase of 268% amongst the top 10 carriers (for which data is available) during the 10 year period 2008–2018.

When the top ten airlines are looked at in terms of total ancillary revenues these airlines earned \$35 billion in 2018, (see Table 2). This is up from only \$8 billion in 2008 representing an increase of 438% over a ten year period. When profits earned per passenger are compared to revenue gained from ancillary services alone, it can be observed that airlines worldwide earned circa \$6 per departing passenger in 2019 (IATA, 2019), compared to \$23 per departing passenger earned in ancillary revenues and surcharges. Thus, without ancillary revenues and surcharges, airlines worldwide would have reported a loss of \$17 per departing passenger.

Ryanair was an early adopter of the ancillary revenue business model. Ryanair's ancillary revenues, which comprise revenues from non-flight scheduled operations, in-flight sales and internet-related services, increased by 21%, from €2017.0m in fiscal year 2018 to €2436.3m in fiscal year 2019, while ancillary revenues per booked passenger increased by 11% to €17.15 from €15.48. 30% of overall revenues now come from ancillaries (Ryanair Annual Report, 2019). By May 2017, 22 million passengers had subscribed to My Ryanair and the Ryanair App had been downloaded 21 million times. O'Leary (2017),

Table 1
Ancillary revenue per passenger top 10 airlines 2018 v 2008.

Annual Results – 2018 (in millions US\$)		Ancillary Source	2008 Comparison (in \$US and % increase above 2008)	
\$50.94	Spirit	Various	\$18.61	174%
\$50.01	Allegiant	Various	\$26.66	88%
\$47.62 ^a	Frontier	Various	\$3.70	1187%
\$43.91	Jet2.com	Various	\$19.04	131%
\$41.15	Qantas Airways	FFP	\$15.83	160%
\$36.64	United	Various	\$22.86	60%
\$35.56	American	Various	\$19.67	81%
\$34.74	Virgin Australia	Various	Not available	
\$34.28	Air Asia X	Various	Not available	
\$32.70	Hawaiian	Various	Not available	

2018 results were based on 12 month financial period disclosures.

Local currencies converted to \$US at July 2018 and July 2008 rates of exchange.

^a IdeaWorksCompany estimate based on past disclosure and updated for current report.

Source: IdeaWorks (2019)

Table 2

Top ten airlines for ancillary revenues in 2018.

Annual Results – 2018 (millions US\$)		Approximate Source of Revenue	
		FFP	A la carte such as bags Travel retail commissions
American	\$7,245	77%	23%
United	\$5,802	73%	27%
Delta	\$5,570	74%	26%
Southwest	\$4,049	84%	16%
Ryanair	\$2,802	0%	100%
Lufthansa	\$2,628	32% ^a	68% ^a
Group			
Air France/ KLM	\$2,579 ^a	21% ^a	79% ^a
EasyJet	\$1,598	0%	100%
Spirit	\$1,493	3%	97%
Air Canada	\$1,453	39%	61%

2018 results were based on recent 12 month financial period disclosures.

Local currencies converted into \$US at July 2018 rates of exchange.

^a IdeaWorksCompany estimate based on updated past disclosures and other sources.

Source: IdeaWorks (2019)

stated that he expects that revenues generated by My Ryanair will greatly exceed the revenue generated by the airline. The CEO stated that the 'potential is fantastic' and that Ryanair would set their sights on the website Booking.com and go direct to hotels, offering them a low 5% rate of commission, instead of the commission rate of 12%–14% offered by Booking.com. Ryanair would then offer the customer the 5% off as a hotel discount, so in essence Ryanair, initially, would be earning nothing on the transaction but would be building market share. The growth of market share by competing at very low margins, gaining a large percentage of revenue from commission based external suppliers that use their website as a market place, is very similar to how Amazon.com works.

Ryanair has declared that they want to become the "Amazon of Travel", and be the trusted hub for anyone wanting to buy travel related products, be they flights on Ryanair or other airlines (Jacobs, 2017). Jacobs, the CMO of Ryanair, stated that Ryanair wanted to be involved in the sale of flights, even in countries where they have no flight operations at all. He said that Ryanair.com was now the world's most visited travel website and that Ryanair could leverage this to sell flights from the USA to South America and take commission sales. Ryanair's plan is very much in line with IATAs "One Order" initiative, helping airlines turn from seat-centric to customer-centric organisations with enhanced personalization capability and the sale of complementary products to the core flight element.

While Ryanair has leveraged much revenue from its ancillaries, Warnock-Smith et al. (2015) explain that there is a moderate correlation between a carrier's focus on ancillary revenues as a percentage of total revenue, and operating profit as a percentage of total revenue. Low Cost Carrier's such as Allegiant (32% and 17%) and Ryanair (26% and 14%) are prime examples, whereas on the other end of the scale carriers such as PIA (1% and –18%) and SAA (2% and –1%) demonstrate both a low percentage of ancillaries and a low profit to revenue percentage (IdeaWorks, 2016; IATA, 2013).

O'Connell and Warnock-Smith (2013) describe ancillary revenues as income beyond the core product sale of tickets that is generated by direct sales to passengers, or indirectly as part of the travel experience. Direct sales to passengers beyond the sale of tickets are often known as 'a-la-carte' revenues, as the consumer chooses the ancillaries they would like to purchase and those they would prefer to refrain from. Such products are typically referred to as unbundled products, and were traditionally included in the fare price such as assigned seats, baggage and food/drinks. Indirect sales can be seen as commission based ancillaries, provided by 3rd parties, such as car rental and travel insurance companies (Fig. 1). Such commission based ancillaries are also referred

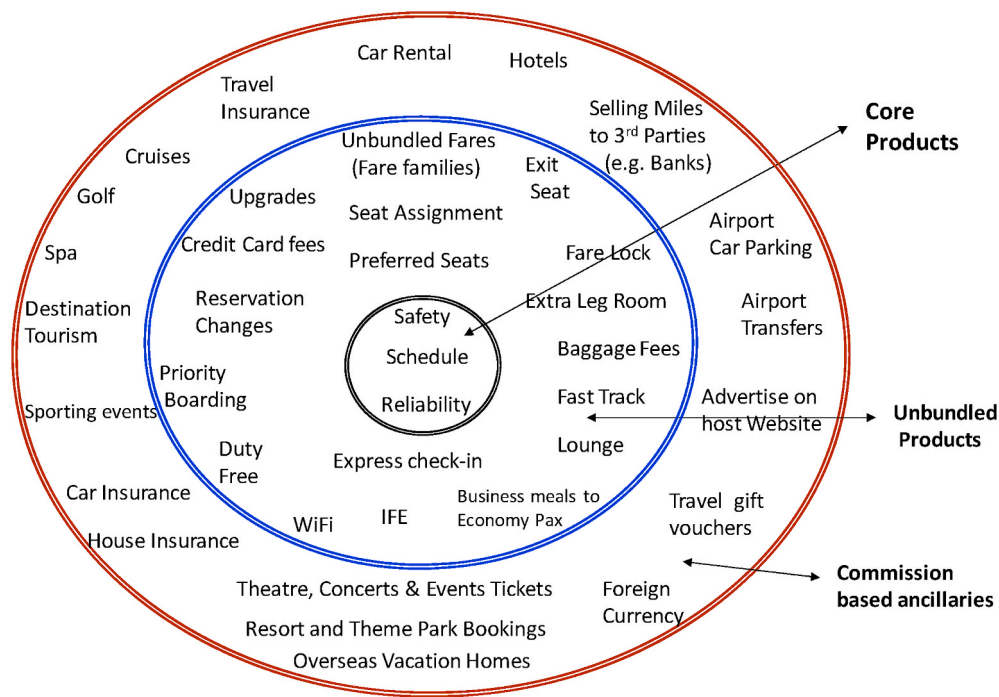


Fig. 1. Types of ancillary revenue.

Source: O'Connell and Warnock-Smith (2013).

to as 3rd party ancillaries.

A-la-Carte revenues derive from the amenities the customer can add to their basic air transport experience (Ideaworks, 2009). The list of potential add-ons include; call centre support for reservations, credit card fees, and the entire gambit of fees to improve the quality of the travel experience including baggage fees, fees for assigned seats or better seats, priority check-in, early boarding benefits, and of course fees for purchasing food and drink on board. According to IdeaWorks (2016), 70% of ancillary revenue among non-US Airlines is generated from excess baggage, on-board services, or other a-la-carte services, with only 15% generated from commission based revenue. This changes dramatically for US airlines. 55% of ancillary revenue in 2014 was from the sale of frequent flyer miles, with the split of a-la-carte services to commission based revenue being 40%–5%, as shown in Fig. 2.

LCCs have long been charging for seats as part of the booking process. The charges have become more sophisticated in the last few years with airlines now charging more, not only for more legroom/emergency exit seats, but also based on where a person wants to sit on the plane.

Legacy carriers have been slower to start charging for assigned seating. British Airways in 2009 was one of the first legacy carriers to announce charges to pre-book seats (The Guardian, 2009). Many other European legacy carriers held off implementing these charges. In April 2014, Lufthansa introduced advanced seat charges but it was not until January 2016 that Air France/KLM announced charges for pre-booking certain economy seats on specific routes (Business Travel News, 2017). Meanwhile non-European airlines delayed even longer, with Emirates introducing fees in October 2016. Many Airlines from Aer Lingus to Etihad and even to Singapore Airlines (from July 2016) have allowed customers to bid to upgrade their class of service in small windows (often 7 days) prior to departure covering certain fare types (Schlappig, 2016). These upgrades are often restricted and may not include certain perks, such as chauffeur ground transport with Etihad, but they do allow the customer to benefit from a higher class of service and for the airline to fill up empty premium seating.

Even legacy flag carriers such as British Airways have now cut free food and drink options for Economy passengers on short-haul routes. On

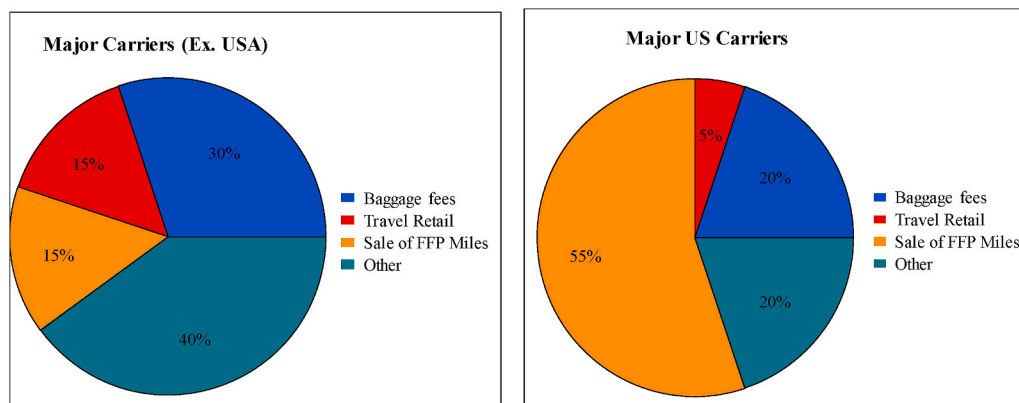


Fig. 2. Ancillary revenue breakdown US carriers v Non US carriers.

Source: Ideaworks (2014), non-US figures exclude LCC's

long haul, most carriers offer free food, with the option to upgrade becoming more commonplace. Airlines, such as Aer Lingus, United, and KLM, now offer the opportunity to upgrade meals up to 24 h before departure to a 'business class meal'.

Dron (2017) found that a large percentage of airline passengers would rather have an internet connection than food on board a flight. In recent years many airlines have started to install Wi-Fi across their fleets (Gilbert, 2016). Initially, this service was quite slow and in some cases more frustrating than useful. Some airlines such as Norwegian (on selected routes), Qatar, and Turkish Airlines offer free Wi-Fi across all cabins, while Aer Lingus only offers free Wi-Fi on its long haul flights in business class. In-flight Entertainment has generally been free to use even since its inception. Some airlines are now starting to offer expanded services in economy class for a fee.

Additional charges can range from a call centre charge fee of £15 with Norwegian to a price lock feature with Aer Lingus for €5 per passenger per flight, or €2.50 per passenger per flight with Ryanair. The difference being that, with Aer Lingus, if you take the flight, the fee is deducted from the fare and with Ryanair the fee is an extra charge and not deducted from the fare. Many LCCs will charge to reprint your boarding pass (£15 with Ryanair) or for a name change (unless to correct a spelling mistake). Some charges such as a name change fee with Ryanair can be seen as punitive because of their very high charges; Ryanair charges between £110 and £160 for a name change. Schaal (2014) reports that US carriers alone generated \$675 million in change fees in the fourth quarter of 2013. To encourage more Ryanair customers to check-in bags and reduce the volume of carry-on bags, Ryanair increased the check-in bag allowance from 15 kg to 20 kg for all bags while lowering its check-in bag fee from €35 to €25 costing the carrier €50 million per annum (Ryanair, December 2017).

Airlines may charge up to 3% for credit card bookings. May (2017) reports that British Airways charge an £8 per booking fee on bookings via third parties that use a system that does not use a New Distribution Capability-led connection. This has the potential of making the carrier visually more expensive compared to other airlines when flights are booked on a third party website but BA says it is looking to recoup the cost of these bookings, which it has historically been subsidising.

3. Development of airline third party ancillary revenues

Led by LCC's, many airlines have started to offer services during the transaction path that would traditionally be offered by other suppliers. Revenue derived from commission based ancillaries are generally for products/services offered for sale by the airline but are actually provided by a third party. The airlines collect revenue from the sale of the service without having the costs of operating the service itself. Examples include the commissions earned by airlines on the sale of hotel accommodation, car rentals and travel insurance. The commission-based category primarily involves retailing via an airline's website, but it can include the sale of duty-free and consumer products on board the aircraft (Ideaworks, 2017). O'Connell and Warnock-Smith (2013) state that the advent of the internet has helped shift power from the supplier to the consumer, with the consumer becoming their own travel agent. They can build tailor made packages that suit their individual requirements. This process known as dynamic packaging (dynamic because it relies on real time pricing and availability of inventory, which ultimately effects the choices a consumer makes). As large brands in their own right, many airlines are able to capitalise on their strong internet presence to sell commission related products through their own platforms.

The sale of car rental is a logical progression for airlines. According to Auto Rental international, the global car rental market was worth US \$51 Billion in 2014, with the European car rental sector being worth approximately €12 billion. Car rental at airports or as part of the travel experience plays a huge part in this, as 60% of all car hire takes place at airports (O'Connell, 2011). Airlines such as Ryanair have been offering

car hire since the 1990's. It was a natural step to combine the offer of flights and car hire to Ryanair customers, thus giving the carrier a greater share of consumer trip spend, without having to incur any of the cost of provision. Ryanair had an exclusive agreement with Hertz since 1997 but this agreement was terminated by Hertz in early 2015. This car hire agreement was highly lucrative; Ryanair alone earned approximately €32 million from Hertz in 2009, thanks to a commission rate of 12%–18% (Sorensen, 2017).

One of the advantages of the agreement for Hertz was that any passenger booking a fare with Ryanair had to book online with the Ryanair website and thus would have had the opportunity to book a Hertz car rental. However, in early 2014, Ryanair once again started using GDS's (Global Distribution Systems), which meant that travel agents could book flights without going through the Ryanair.com website and thus these passengers were not being automatically offered Hertz car hire. Ryanair now use the specialist ground transportation provider Cartrawler to provide this service. Cartrawler was founded in Dublin in 2004 and provides the offering of over 2000 travel retailers and to over 95 airlines across, not only the LCC segment, but also to the likes of Emirates, LOT, and Hawaiian Airlines. The airline offers a car rental or other ground transportation services to its consumer and Cartrawler organises the provision of the service for the airlines. The airline takes a percentage of the fee as a commission for what was, in essence, a customer referral.

Even though some airlines such as Qantas and Icelandair have their own holiday subsidiaries, for years most airlines have been foregoing huge volumes of travel related revenue, as the consumer has booked these products via alternative suppliers. LCCs such as Ryanair have been offering car hire and hotel bookings separately via their website for many years, launching an ATOL bonded on-line travel agent - "Ryanair Holidays Online" in 2016. Ryanair offered a choice of 25,000 hotels in Europe that they bundled with their flights to offer the consumer an entire package. However, in 2019 Ryanair announced its discontinuation of the package holiday service after it failed to take off (O'Conghaile, 2019). EasyJet launched its "Easy Jet holidays" platform in 2011 and has expanded it across Europe (Topham, 2016). This type has platform has the potential to earn airlines a higher commission rate by working exclusively with a lower number of suppliers on their branded holiday and hotel webpages.

Many airlines have offered the sale of travel insurance via their transaction channels for the last decade, with some airlines such as Ryanair and British Airways offering a multi-trip year-long version. In recent years, some airlines such as Ryanair (June 2017) have reported a softening in demand for travel insurance, as it becomes more commoditised. Despite this commoditisation, travel insurance remains one of the big three 3rd party ancillaries, in terms of revenues earned after hotels and car hire.

Many airlines have started to offer parking, airport fast-track, and access to executive services at the airport, making a commission on the sale of these services. easyJet offers a new premium ancillary product, where passengers can board from the private jet terminal at London Luton Airport for a £475 fee. This VIP service is being offered in partnership with executive jet handling company, Signature Flight Support with easyJet as the preferred partner. easyJet markets the service via its website and "below-the-line advertising", receiving a commission from Signature (Moores, 2017).

Ryanair entered into a new car parking deal with Dublin Airport Authority (DAA) in February 2016, featuring access to a limited number of car parks, at the lowest parking rates at Dublin Airport. For example, a booking for Terminal 1 short-term parking from 2pm on Friday, February 19 to 8pm on Sunday, February 21 was priced at €29.85. The same booking cost €30.95 through Dublin Airport's website (O'Conghaile, 2016).

Ryanair also earns commissions on the sale of fast-track security. On the same day in 2017, booking fast track via the Ryanair website costed €5.95; and via the DAA website, it costed €6.49. It should be noted that

booking fast-track via the DAA also qualified customers for 10% off at the airport's loop duty free stores. Clearly there is a competitive element to the generation of additional 3rd party, commission based or direct revenues even between parties that otherwise co-operate quite closely.

It is clear that airlines have started to venture more seriously into the area of third party ancillary products and services, recognising their importance as a developing revenue stream. The success of many of these product/service offerings will stem from tapping into to travel customer willingness to pay for such items and converting them from more traditional purchasing methods. Though not focussed specifically on 3rd party airline ancillary services, Morosan (2014) found that if air carriers are able to convince their customers of the perceived usefulness, ease of use of and trustworthiness of mobile phone apps, then there is a significant opportunity for airlines to sell ancillary products and services through these platforms, thereby increasing the chances of conversion.

4. Willingness to pay and customer conversion

As ancillary products and services are discretionary, understanding passenger willingness to pay is crucial. If a passenger is not willing to pay for something then there is little point in an airline offering the specific service or product. O'Connell and Warnock-Smith (2013) state that a common concern for all carriers when adopting ancillary services is the impact on perceived service levels. Gollan (2017), reported that British Airways struggled with the implementation of charging for food on its short-haul routes and the impact that charging for same would have on customer satisfaction. Upset passengers took to Twitter to question whether British Airways was still a "full service airline" and there was an entire thread on the travel forum [Flyertalk.com](#) dedicated to the changeover (Gollan, 2017). Warnock-Smith et al. (2017) state that Full Service Carriers (FSCs) are struggling with profitability (when ancillaries are excluded) and that maintaining customer satisfaction is essential to keeping passenger yields up. For such airlines, the challenge is to introduce ancillaries, which fit customer needs, and do not come across as just another way of charging for something" (Airline Business, 2009).

In general, the products that customers want the most are those, which they are willing to pay a higher price for, often guaranteeing the provider with the highest margins (Bhaskara, 2015). An influencing factor is the notion of perceived price fairness, with consumer sensitivity to several reference points, including past prices, competitor prices, and cost of goods sold (Bolton et al., 2003; Chung and Petrick, 2013). Price comparison and cognitive attribution influences price fairness, which in turn leads to emotional response and behavioural intentions. Price fairness comes into play when a product is unbundled and the customer is asked to pay a separate price for what would have traditionally being included in the price of the fare (for example, carry-on luggage or, in the British Airways' case, food on short-haul flights - Chung and Petrick, 2013). If the fare is lowered to offset the unbundling, passengers should not object; in theory, however, Bejar (2009) concludes that in general the consumer backlash against the provision of a-la-carte fees indicates a widespread failure on the part of the airline industry to effectively manage consumer expectations in a changed era.

O'Connell et al. (2013) state that LCC's seem to have had more success in training their customers to accept fees in return for lower fares; however, FSCs still have a way to go in this regard. The perception of service levels, especially when it comes to full service carriers, is key. If full service carriers do not balance the requirement to cut cost and drive ancillary revenue with the need to maintain customer satisfaction levels, then they may make decisions that adversely affect perceptions of service. A prime example of airlines getting this balance wrong would be the rollback by Austrian and Swiss on their decisions to cut their short-haul economy food offering in 2005/6. Reals (2017) reports that, in the USA, things have just come full circle, with United Airlines and American Airlines announcing in 2015 and 2016, respectively, that they would re-introduce complimentary drinks and snacks on their domestic

services.

In contrast, O'Connell and Warnock-Smith (2013) found that commission based ancillaries are generally viewed as non-offensive to the passenger and can be seen as value-added extras, which are sometimes worth paying for. Indeed, Liu (2007) highlights the value in terms of revenue generated and increased loyalty from infrequent travellers when deeper co-operation between the airline and non-related companies is pursued. This in turn allows for frequent flyer program air miles to be earned from the purchase of goods or services from non-related companies. O'Connell and Warnock-Smith (2013) do, however, conclude that a notable example of pushy commission based cross-selling was the practice of automatically opting passengers into additional travel products such as travel insurance, which led to a full EU ban of this practice in 2010.

O'Connell and Warnock-Smith (2013) also found that when the overall rankings were examined, it appears that airlines offering airport car parking and those that charge for checked baggage yield the greatest acceptance and willingness to pay, in terms of commission based and unbundled products, respectively. However, it is important to note that acceptance levels for travellers on full service airlines were lower than for low-cost travellers, both for commission based and unbundled services.

When it comes to customer conversion offering multiple opportunities to purchase products/services is likely to lead to increased uptake especially amongst what Bockelie and Belobaba (2017) describe as 'sequential' passengers (i.e. those that separate out fare class and itinerary decisions from ancillary related decisions). In this regard the provision of on-board Wi-Fi has the potential to increase passenger engagement with ancillaries and hence increase conversion rates. Parry-Ernst, 2017 highlights the importance of Wi-Fi on board allowing airlines to offer targeted content and products to passengers such as hotels and experiences at their destination (e.g. tickets for a theme park). This type of airline-passenger interaction opens the door to a higher level of ancillary revenues through offering a combination of unbundled (e.g. Wi-Fi access) and commission based revenues all through a common platform. Bockelie and Belobaba's 2017 research also found that 'sequential' passengers provide airlines with higher revenues than 'simultaneous' passengers (i.e. those that purchase itinerary, fare class and ancillaries all in one go) so it would follow that having more platforms from which to engage passengers after the initial booking will increase and incentivise greater numbers of passengers to become 'sequential' in their ancillary spending habits rather than 'simultaneous'.

Airlines such as Delta are going beyond the traditional on-board duty free option and in 2012 teamed up with [Amazon.com](#) to allow flyers to surf the [Amazon.com](#) portal for free. Delta then earns a percentage of any items purchased (Tuttle, 2012). Other airlines such as Southwest allow customers to pay for in-flight services with their [Amazon.com](#) account, allowing customers to quickly and conveniently access services on board the flight (Lew, 2016). Finnair has put its new 'Nordic Sky' in-flight portal to work, as a channel to offer new services to flyers, as well as to boost ancillary sales. The portal can be accessed on passengers' own devices and gives all passengers free access to [finnair.com](#), plus Finnair services such as destination information, customer care and pre-order duty free shopping - with items purchased being delivered to the passenger's seat on their return flight (Kollau and June, 2017). Passengers can also use the in-flight portal to order taxis via Cabforce on in-bound Helsinki flights, or book destination services such as trips, dinner cruises, and concert tickets with Viator Destination Services. The airline is also considering allowing passengers to pre-order their groceries in-flight. An innovation from Lufthansa in conjunction with Frankfurt Airport allows passengers on inbound long-haul Lufthansa flights to pre-order a selection of duty free items from retailers at the airport via the Lufthansa in-flight portal and have their orders delivered to them by the airport's 'runners' at their arrival gate (Kollau and June, 2017). IAG's new long-haul low-cost carrier LEVEL is one of several

long-haul LCCs, including Norwegian and Azul, to allow passengers to order food, beverages, and travel accessories via the in-seat IFE system and pay with their credit card via a solution called “Pair & Pay”. Innovation in on-board retail continues in China, with Air China partnering with online retailer JD.com to offer passengers a selection of goods that they can purchase via the in-seat IFE system for delivery to their homes.

Ancillary revenues are expected to become increasingly important for airline profitability. As a result, airlines are constantly seeking to expand the range and reach of such revenues. Airlines are extending beyond the more typical suite of ‘a la carte’ ancillaries and far into the domain of commission based (3rd party) revenues. Given the dearth of academic literature in this area, a number of pertinent objectives were devised as a basis for this study as detailed in section 1.

5. Research design

In order to answer the stated research questions a mixed-methods approach was adopted. A quantitative survey was designed to gauge the current situation in terms of the most prevalent 3rd party revenue streams for airlines and passenger willingness to pay for such services both with standard and discounted pricing.

Nine semi-structured expert interviews were carried out in the months of July and August 2017. The purpose of these interviews was to further inform the research about future trends in 3rd party ancillary revenues and identify current barriers and opportunities that need further development in order to maximise the revenue opportunity. Interviewees were targeted to provide an expert opinion from across a range of geographies and sectors within the broader airline sector. Executives from 6 different airlines, 2 3rd party service providers, and one aircraft manufacturer were interviewed. Five of the interviews took place face-to-face; with Air Asia, Southwest Airlines, Embraer, and FlyBe completed via Skype. The list of interviewees is shown below in Table 3. Using content analysis the categories raised throughout the interviews fell into three broad areas: the role of personal connected devices, customer conversion, and market opportunities (Sections 7.1–7.3).

The survey, consisting of 20 close-ended questions, based around ‘willingness to pay’ for 3rd party ancillary revenues yielded a total of 407 respondents. The survey was undertaken, both airside and landside at Shannon airport in Ireland in 2017. Concurrently, respondents were invited to participate online via Flyertalk, which is an online travel forum, with 683,826 members, as well as linkages through Facebook and LinkedIn. The location of responses was split with approximately 30% coming from both Shannon Airport and Flyertalk, 25% coming via Facebook and LinkedIn, and the remainder coming from airline industry professionals and delegates attending the FTE ancillary revenue conference in Dublin 2017.

Passengers were asked, firstly, to rank how willing they would be to purchase specific 3rd party ancillary revenue types; the choice of specific ancillaries was informed from the literature review stage. Secondly, passengers were asked if specific offers/discounts would impact their willingness to pay for specific 3rd party ancillary revenue types, which in this instance focussed on hotels. Both sections of questioning were preceded by relevant attribute questions around traveller age, length of

flight (i.e. short or long-haul), and frequent flyer status.

The survey data was analysed initially using frequency distributions to illustrate the Likert scale data and its variability in an easy to interpret manner. The use of stacked bar charts, in particular, have allowed for visual comparisons to be made prior to inferential testing. As the data for this study were not normally distributed and data was typically ordinal in nature, non-parametric significance tests were conducted for this study. A Wilcoxon Signed Rank test compared data obtained from the same sample under two different conditions. It was used here as a post-hoc test, to compare differences in willingness to purchase between pairs of the various revenue/offer types (i.e. two categories for each test).

6. Survey results

In terms of sample representativeness, 87% of the 407 respondents said that they travelled for leisure purposes in the last 12 months, 48% for work related purposes, and 34% to visit friends and family, with a sizeable proportion of respondents stating that they had travelled for all three journey purposes during the last 12 months (21%). 43% of the respondents were flying long haul (or had flown long haul on their last flight), with 57% stating short haul. Respondents were asked how they last booked a selection of 3rd party ancillaries, the results of which are summarised in Fig. 3. It is clear that the majority of respondents booked directly with the supplier of the services (i.e. directly with the hotel/car park provider etc.). In fact, when ‘booking directly with the supplier’ and ‘not applicable’ options are excluded, car hire was the only 3rd party ancillary that managed to reach double digit figures, in terms of respondents booking through an airport website, at 11%.

Fig. 4 shows ‘willingness to book commission based products’ with the same airline that respondents were flying with. There were large variances: For example, for hotels only 7% of respondents booked their hotel directly with the airline (Fig. 3), however, 41% said that they would be very willing to do so, assuming there was no difference in the price. This shows an enormous potential for airlines to gain commission based revenue from the sale of hotels via the booking process. Car hire follows similar lines, with only 11% of respondents saying that they booked their last hire car via the airline (Fig. 3). However, 39% said that they would be willing to do so, given no difference in price. It can also be observed in Fig. 4 that passengers are most willing to purchase Hotel, Car Hire, and Airport Parking as 3rd party service categories from airlines. Large proportions of passengers are unwilling to purchase Travel Insurance and Resort Attractions. A large proportion of passengers selected ‘Cruise’ as ‘Not applicable’.

Respondents were also asked if various offers would make them more willing to move from booking 3rd party services (in this case a hotel) via a direct supplier (Fig. 5). The promotions included a hotel price guarantee, 15% off their next flight with the airline, air miles on the entire booking, free allocated seating on board the plane, and a free 15 kg bag per booking. As can be seen, 56% of respondents replied that 15% off their next flight would make them more willing to book their hotel via the airline, instead of direct with the supplier. The offer of air miles on the entire booking and a hotel price guarantee were the joint second best promotion when it came to the ‘very willing’ option.

Table 3
Expert interviewee details.

Name	Abbreviation used for discussion	Company	Title
Aidan Brogan	AB	Datalex	Chief Executive Officer
Bobby Healy	BH	Car Trawler	Chief Technology Officer
Enda Corneille	EC	Emirates	Head of Country
Greg O’Gorman	GOG	Ryanair	Director of Ancillary Revenue
John Slattery	JS	Embraer	President and CEO
Julian Khoo	JK	Air Asia	Senior Product Manager
Mary Wharton	MW	Southwest Airlines	Director, Network and Revenue
Rory Breslin	RB	Aer Lingus	Head of Retail
Susie Reckitt	SR	FlyBe	Head of Commercial Development and Ancillary

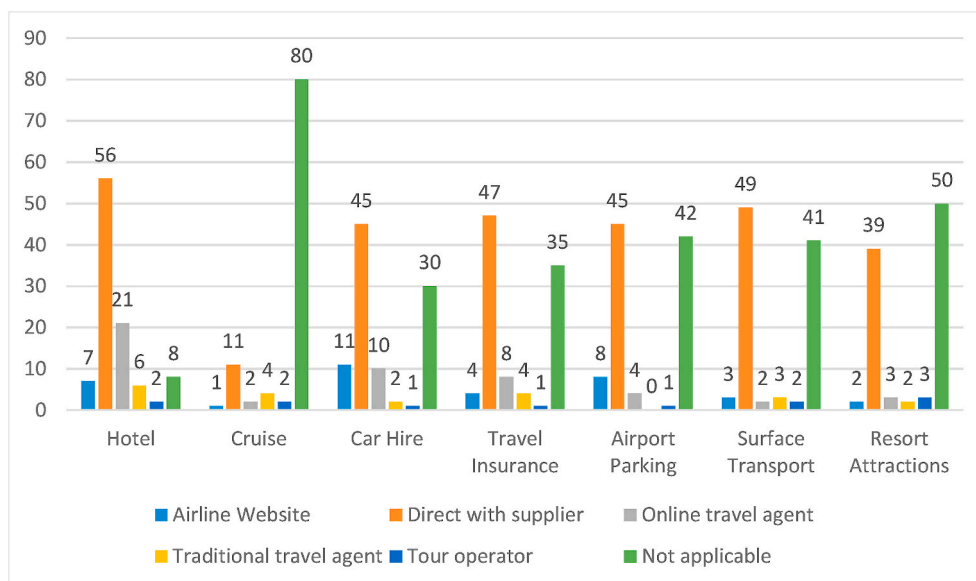


Fig. 3. How respondents last booked a selection of 3rd party ancillaries.

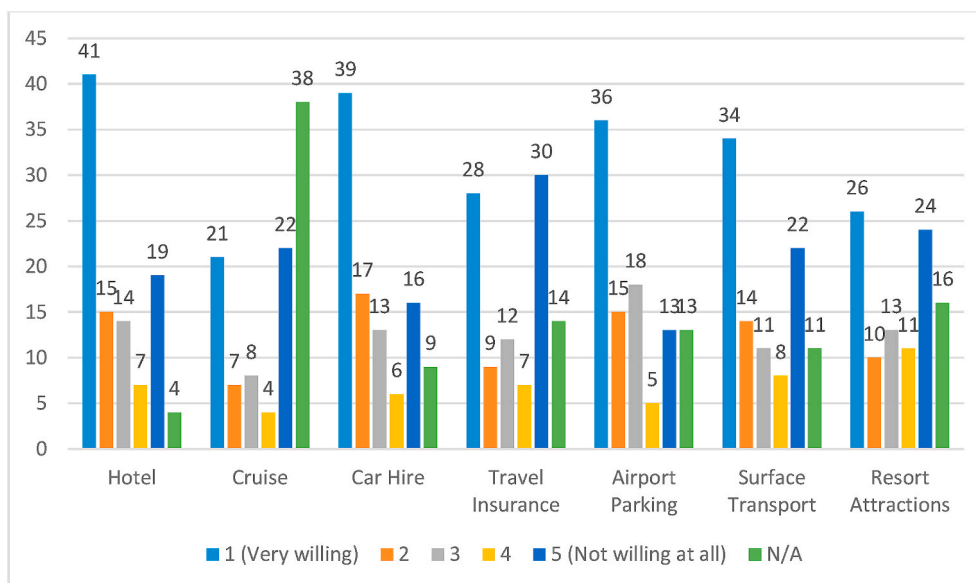


Fig. 4. Willingness to book 3rd party ancillaries via the airline booking process.

Figs. 6 and 7 disaggregate the responses into short and long haul 3rd party ancillary preferences respectively. Patterns in the revenue types that passengers are willing or unwilling to purchase (or deem to be not applicable) are remarkably similar to those seen for all passengers (Fig. 4). This shows that when it comes to 3rd party ancillaries airlines can look to earn commissions on flights of any sector length with the top three priority areas consistently appearing to be Hotels, Car hire and Airport Parking.

Using the Wilcoxon Signed Ranks test, to a high degree of significance the respondents demonstrated that they were more willing to purchase hotel services than cruise services. Car hire was also considered to be a more popular 3rd party ancillary revenue than hotels at the 2% confidence level. In line with the descriptive results car hire, hotels, and airport parking receive the highest level of statistical significance as 3rd party products that airlines should be focussed on (Table 4).

The survey results also show that the linking of a hotel stay to a discount off the passenger's next flight and providing a hotel price

guarantee were the strongest offers when it came to making passengers more willing to purchase 3rd party hotel services from airlines (Fig. 8). When contrasted against the overall willingness to purchase results for hotels, the availability of discounts/offer does not appear to have a marked effect with the exception of providing discounts off future flights (52% willingness to pay versus 40% overall). In this situation, airlines would have to present a strong business case with extra hotel sales commissions in excess of the costs of offering future flight discounts in order to make such offers worthwhile.

Responses were again split between long and short haul passengers but the differences in willingness to pay with offers and discounts added were again shown to be negligible in comparison to the sample as a whole. Therefore, there is no evidence to suggest that airlines should be focusing on marketing offers and discounts related to 3rd party ancillary purchases purely based on sector length.

The Wilcoxon Signed Ranks test was repeated to check the preferred offer types among the respondents (Table 5). It is clear that discounts off

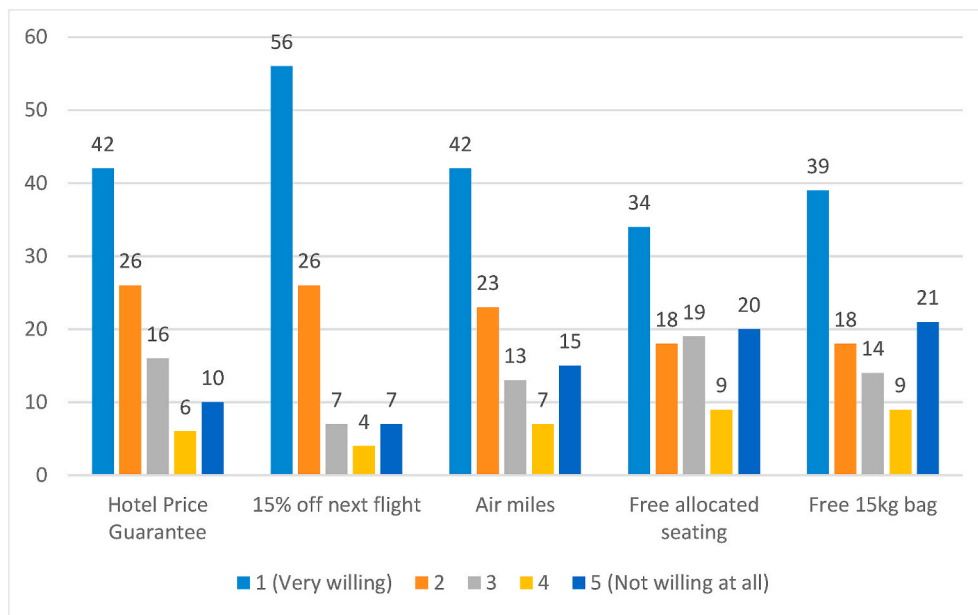


Fig. 5. Willingness to book 3rd party ancillaries via the airline booking process.

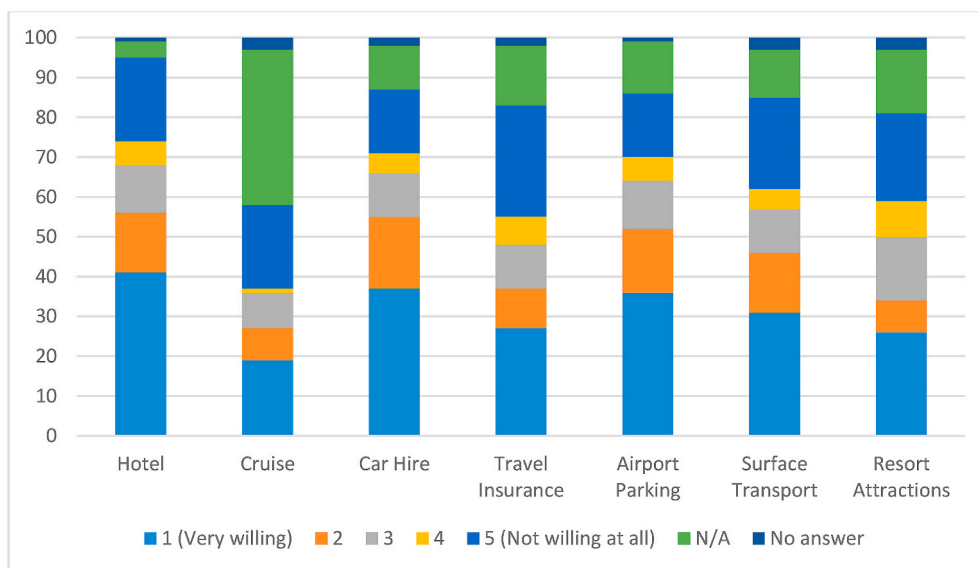


Fig. 6. Willingness to purchase of short-haul passengers for each ancillary revenue type (Short Haul n = 229).

future flights and to a lesser extent hotel price guarantees should be the priority areas for airlines seeking to secure a greater take up of commission based selling through their own platforms with the same proviso that the commission rate incomes can suitably exceed the cost of discounting.

Overall the survey results indicate untapped potential for airlines to increase the 3rd party ancillaries offered to customers.

7. Interview results and discussion

3rd party ancillary sales offer huge potential revenue streams to airlines, but leveraging this opportunity will hinge on a number of key factors, which emerged from the interviews conducted with industry experts. The key to converting this willingness to pay as demonstrated through the survey findings, into bottom line revenue for airlines centres on the following:-

- The use of personal WiFi connected devices to unlock the sale of further commission based products and services during flight;
- Conversion; in terms of using forced and optional account registrations to enhance data, the timing of offers and therefore conversion rates;
- Making the most of potential market opportunities given the air carrier is the 'stickiest', most critical part of the travel experience.

7.1. Personal connected devices

All the interviewees highlighted the importance of the use of personal devices, linking the provision of Wi-Fi directly to the potential for revenue. In addition, some interviewees felt that on-board Wi-Fi was more of a necessity, increasing the strength of the overall offer and will indeed become a hygiene factor.

All the interviewees agreed that mobiles would play an important

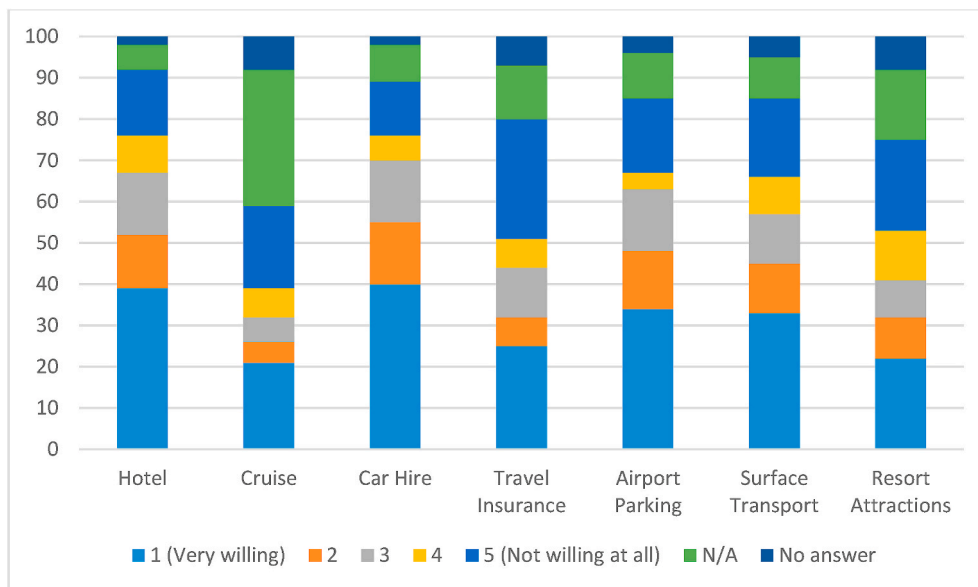


Fig. 7. Willingness to purchase of long-haul passengers for each ancillary revenue type (Long Haul n = 175).

Table 4

Summary of related-samples Wilcoxon Signed Rank tests.

Revenue Type 1	Revenue Type 2	P	n	More Willingness to Purchase
Hotel	Cruise	<0.001	236	Hotel
Hotel	Car Hire	0.001	355	
Hotel	Travel Insurance	<0.001	332	Hotel
Hotel	Airport Parking	0.288	339	-
Hotel	Surface Transport	<0.001	346	Hotel
Hotel	Resort Attractions	<0.001	321	Hotel
Cruise	Car Hire	<0.001	228	Car Hire
Cruise	Travel Insurance	0.186	215	-
Cruise	Airport Parking	<0.001	227	Airport Parking
Cruise	Surface Transport	<0.001	223	Surface Transport
Cruise	Resort Attractions	0.102	219	-
Car Hire	Travel Insurance	<0.001	213	Car Hire
Car Hire	Airport Parking	0.246	332	-
Car Hire	Surface Transport	<0.001	328	Car Hire
Car Hire	Resort Attractions	<0.001	302	Car Hire
Travel Insurance	Airport Parking	<0.001	306	Airport Parking
Travel Insurance	Surface Transport	<0.001	308	Surface Transport
Travel Insurance	Resort Attractions	0.277	291	-
Airport Parking	Surface Transport	<0.001	319	Airport Parking
Airport Parking	Resort Attractions	<0.001	296	Airport Parking
Surface Transport	Resort Attractions	<0.001	306	Surface Transport

Note: Significance is considered to be reached at $p < 0.002$.

role in the future of revenue generation in the airline sector, whether it be 3rd party ancillary revenue or indeed any revenue., which corroborates the research undertaken by Morosan (2014) as described in Section 3. From an aircraft manufacturers perspective John Slattery (CEO

Table 5

Summary of related-samples Wilcoxon Signed Ranks tests.

Offer Type 1	Offer Type 2	p	More Willing to Purchase
Hotel price guarantee	15% off next flight	<0.001	15% off next flight
Hotel price guarantee	Air miles	0.029	-
Hotel price guarantee	Free allocated seating	<0.001	Hotel price guarantee
Hotel price guarantee	Free 15 kg bag	<0.001	Hotel price guarantee
15% off next flight	Air miles	<0.001	15% off next flight
15% off next flight	Free allocated seating	<0.001	15% off next flight
15% off next flight	Free 15 kg bag	<0.001	15% off next flight
Air miles	Free allocated seating	<0.001	Air miles
Air miles	Free 15 kg bag	0.011	-
Free allocated seating	Free 15 kg bag	0.311	-

Note: Significance is considered to be reached at $p < 0.002$.

Embraer) (JS) stated that the aircraft Embraer sell are already e-enabled for maintenance and on-board Wi-Fi and connectivity, especially in the E2 platform. He added that Embraer's motivation is 'to present to the airline customers a product where they can generate the maximum revenue using the fastest possible Wi-Fi connectivity'. All E2 platform aircraft will be Wi-Fi enabled and the idea that millennials and subsequent generations will be prepared to accept a product that does not offer a connectivity option, will not be tenable, even for a short haul flight. Increasingly people will bring their own iPad and/or mobile phone on board and use the on-board connectivity. Enda Corneille (Emirates Ireland Manager) (EC) believes that the provision of on-board Wi-Fi will 'go the way of roaming charges. It will become a hygiene factor, which has to be built into the overall proposition/price; It is a bit like the hotel industry - the airline customer will expect it for nothing. This will be the case for both short and long haul'.

Julian Khoo (Air Asia) (JK) stated, that Wi-Fi 'is the new fuel for selling ancillary revenue and no matter the length of the flight customers want to be able to connect digitally now and fast'. Air Asia are striving to change their entire fleet over from L-Band to broadband to allow for streaming over the next few years. As it stands, 50 out of 220 planes are Wi-Fi enabled

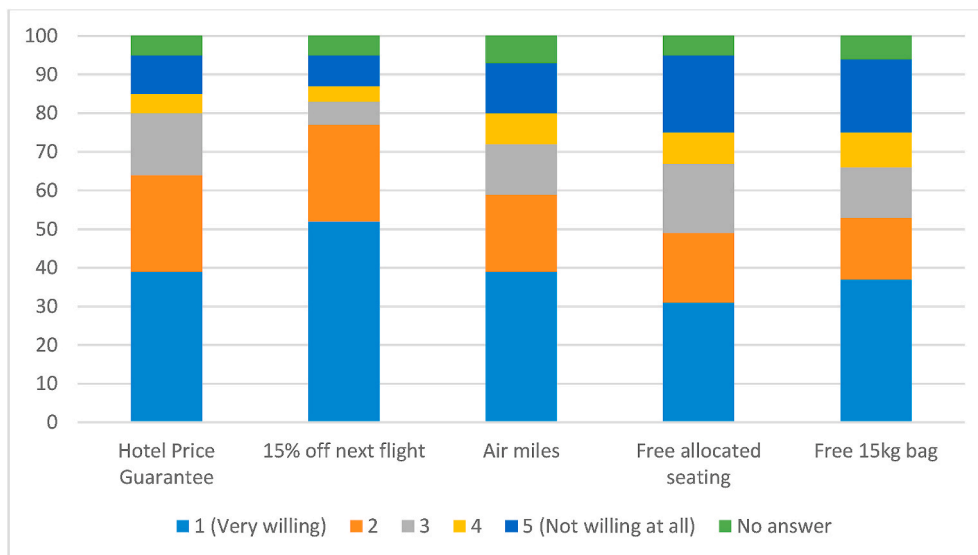


Fig. 8. Willingness to purchase for each offer type (All pax, n = 407).

and another 1/3 will be added in 2018.

Southwest do not have 100% of the fleet Wi-Fi enabled but the majority are with Mary Wharton (Director Network Revenue SWA) (MW) explaining they already do deals with companies to sponsor their free TV on board via personal devices (at time of interview it was Dollar Rent-a-Car); SWA can definitely foresee a future where they would provide free Wi-Fi for customers to increase commission based revenues by shopping on amazon, for example. MW added that *'Southwest believe that offering Wi-Fi on board their aircraft gives them an advantage and in fact Southwest know (from their own internal research) that when JetBlue did it before everyone else they got an advantage but it took a while to catch on'*. JetBlue's implementation of Wi-Fi on board directly added to their gain of market share. MW also stated that Southwest need to try make Wi-Fi cheaper and faster.

In contrast Greg O'Gorman (Ryanair, Director Ancillary Revenue) (GOG) said that Ryanair are not looking at the provision of Wi-Fi because of its effect on fuel burn. Susie Reckitt (SR), FlyBE's Head of Commercial Development and Ancillary concurred with this decision from a FlyBE perspective though without offering a specific explanation. GOG further stated that Ryanair had looked at a server on board, instead of Wi-Fi, but that the experience of doing this was that customers expect to have a connected system and that customers will just be disappointed with any system that is provided if it is not connected to the internet. He raised the question on how to monetise Wi-Fi, stating *'that no one has yet proven that there is money to be made on it. When someone else on short haul in Europe has proven it works, Ryanair would look at it closer'*.

Rory Breslin (Aer Lingus, Head of Retail) (RB) explained that Aer Lingus will use timing more than geo-tagging to send out push notifications via an app (flight minus a few days, one day, 2 h, etc.). He explained it is *'less about location and more about time to flight, as customers are more likely to buy certain products at certain times'*. EC said that it is all about mobile connectivity and being clever about understanding where your customer has been in the past and might like to go to in the future and what travel needs they might have and matching your offering accordingly. MW reiterated the importance of mobile connectivity, saying that 60% of their customers now book via a mobile either on app or via a browser.

Offering the perspective of a 3rd party ancillary service provider, Bobby Healy (Car Trawler) (BH) said that it is not just the mobile itself but the adaption of an app. He felt that push communication used to be via email and was not an effective way to communicate but that push notifications via an airline app is fantastic. He said that *"once we know where the little blue dot is we know so much more. We can target customers*

completely differently'. He further explained that it is too early to say what the conversion rates via an App to purchase will be but that industry statistics say that the propensity to click on a push notification is 50 times more than on an email.

7.2. Conversion

Conversion focuses to moving a potential customer into a fully-fledged customer or indeed to encourage that customer to spend more. GOG stated that targeting the customer centres on awareness and then targeted timing. GOG explained that *'it is important that customers are aware of the ancillary and that the company has the right range and quality of products at the right price. Ryanair needs to educate the customer at the start of the booking process and, as they come through the booking process, offer them something that is right for them; the way to do this is through the use of various forms of data/meta data'*. GOG pointed out that Ryanair has the advantage in that they know where and when customers are going and how many of them are going and has previous purchase history. Ryanair has the data and they do not need to spend the money on google advertising, since they are sitting on the data already, which is a key advantage over other airlines. Since the Autumn of 2016, all customers who book via Ryanair have to register with the airline in order to book a flight and this is an enormous benefit.

The second part of targeting a customer is understanding the right time to contact or sell to the customer. As BH pointed out, different products are booked on different time frames and if you understand when the customer is more likely to book a product, you will obviously increase conversion. As EC pointed out, *'certain ancillaries should not be sold during the booking process; that car hire is an impulse buy, whereas hotel is much more complicated; car is a commodity, while hotels are not'*. EC pointed out that there is much greater emotional attachment to certain types of hotel bookings that an airline might not want in the booking path. The airline will want to make the booking path as straight forward as possible and then encourage conversion afterwards. Julian Khoo (JK) agreed, stating that *'Air Asia are actively taking ancillaries out of the booking path (in some cases, to just post payment), as they find that this increases the conversion rate'*. BH pointed out that there are already clear times to encourage a customer to book certain products; he gives the example of what an airline might sell on-board a flight (e.g. the on-board phase might be a great time to book the likes of hotel transfers).

EC also delved into why certain OTA's (Online Travel Agents) have a much greater conversion rate when it comes to the likes of hotels, than hotels booked via an airline; EC pointed out *'that the likes of Expedia are*

perceived by the public as a travel agent and they have the entire range of products in their inventory that a traditional travel agent might have'.

AB pointed out that the use of data to make more relevant offers to the customer can dramatically increase conversion. He gave the example of JetBlue who made an additional \$280 million USD in incremental profit solely by offering the exact same products but doing so in a segmented way. **EC** pointed out that he does not think that one-to-one segmentation will exist in the short to medium term for several reasons, including the new EU rules on Data privacy, but that meta-data will be used to give generalist conclusions on customer segments.

JS added that in the longer term he believed this might come down to one-to-one personalization, going by previous behaviour, as well as looking at what a broader cohort of customers might purchase; however, in the short term, it will be more segment based. **BH** added that machine learning gives us only an incremental optimization. If you are making a margin of 30%, it may give you a 31/32% - that incremental advantage in a commodity world is the difference between winning and losing. **AB** also pointed out that anything that can help make the selling process easier for the consumer is bound to increase conversion and that the next two waves of real dynamic pricing will be, 'firstly, that the offer does not exist until the customer requests it and, secondly, the area of artificial intelligence and machine learning.' The pricing of ancillary will go from manual to AI and machine learning to control the offer. **AB** also gives the example of an airline they work with that includes the weather into their offer modelling, in order to educate the consumer about the opportunities that may exist in the region that the airline is selling tickets to; 'this might be anything from the weather favouring wind surfing to the perfect time to lie by the beach'. **AB** also gave the example of the use of We Chat in China, where users can buy airline tickets straight out of their bank account. He pointed out that in Europe all banks in the next two years will have to offer their customers the ability to connect directly to their bank accounts from digital providers. **BH** echoed the importance of ease of use, highlighting the importance of one touch purchasing via an airline app.

In terms of the range of products offered as ancillaries, **EC** pointed out that it will be hard to stray from the trinity of hotels, car hire, and insurance¹ in the short to medium term. **GOG** added to this by saying that Ryanair wanted, in general, to improve the sales of what they are currently offering, rather than to go into new products, with the exception of in-resort activities, which will be launched for sale this autumn via the Ryanair app. He did add that the sale of other airline flights via [Ryanair.com](https://www.ryanair.com) remains on the radar with the launch of the sale of seats on Air Europa already in 2017 and the potential tie up with Norwegian and Aer Lingus for the sale of long-haul flights. **EC** added that the likes of Ryanair and easyJet have huge audiences but would question whether one can stray too far from the sale of air travel related products.

7.3. Market opportunity

GOG stated the big opportunity is that Ryanair have the data (with 500 million website visits each year), 'we also know when they (the passenger) are engaging with our mobile device; a lot of customers check-in via the app so that gives us the opportunity every time they use the app to offer them something that is relevant at that point in time that might be as simple as if the customer is in London offer them a ticket to Madame Tussauds or if they are going to France a ticket to visit Notre Dame'. **GOG** goes onto say that Ryanair can offer the customer something relevant at the time, i.e. fast-track at security or even when they are at the airport drive customers to retailers in the airport with the use of relevant offers.

Aidan Brogan (**AB**) tells us that, on average, '1% of people book a hotel at the airline booking stage and 2/3% rent a car, whereas on Expedia 50% plus buy a flight and hotel. Airlines want more of this market and the

challenge for the airlines is to educate the customer. Price and marketing and educating the customer will drive this conversion. **BH** continued on the same vein but says that car hire is between 2/5%. **AB** stated that the customer has to be able to trust the airline and the hotel presented has to be relevant. **JK** states that Air Asia are looking towards retail as the future of ancillary revenue. Air Asia have launched their own retail website - www.bigdutyfree.com - and Air Asia sees the potential for this site to drive revenue as one of the key drivers for them in the medium term.

JS states that the flight is only one small part (of the travel experience) but is still the stickiest part of the value chain. If the airline can influence spend of the customer from when they book the ticket, and throughout the journey, the opportunities are enormous; airlines have the ability to own the customer for the full travel experience. **JS** continued by saying that 'the airline that runs the flight experience is the most trusted party in the travel experience and so the opportunity is there for the airline to reach out and own more parts of the revenue generating experience'.

JS added to this by saying that the expectation is that 3rd party ancillary revenue will continue to grow to a meaningful percentage to the top line revenue for the airline sector and that the quantum and quality (margin) of revenue will continue to increase. The airlines that accept and adopt big data will be the winners. **BH** concluded by saying that on a flight of 200 people, at the moment, 20 book cars, 2 are captured by the airline, and the rest leak to other channels. The airline's target has to be to get from 10% to 100% of the 20. The airline has to have massive advantage over everyone else.

8. Overall conclusions and managerial implications

This paper has shown that there is potential for further 3rd party ancillary revenues for airlines in the coming years. The substantive survey indicated that passengers are willing to pay airlines for specific 3rd party ancillaries; namely car hire, hotel accommodation and airport parking; and that some promotional offers can increase the baseline willingness to pay (e.g. discounts for future flights). It was also found that travel insurance as a 3rd party revenue stream has started to soften with services like airport parking gaining more traction in the survey.

Some important future trends have also been outlined by nine industry experts that are key to converting this willingness to pay into bottom line revenue for airlines namely personal connected devices; not so much for unbundled Wi-Fi revenue, but for the way it can unlock the sale of further commission based products and services during flight. Conversion in terms of using forced and optional account registrations to enhance data, the timing of offers and therefore conversion; and finally by making the most of potential market opportunities given the air carrier is the 'stickiest', most critical part of the travel experience will become even more pertinent in a reduced overall demand post-Covid environment.

Significant opportunities exist for airlines of all types to generate increased revenues by going beyond a-la-carte and frequent flyer ancillaries and re-focusing on a new wave of 3rd party ancillary revenues. The core to generating these increased revenues is to understand how to increase both customer awareness and customer conversion. The accumulation and correct use of customer data (in conjunction with suppliers) including the use of big data, along with the understanding that the customer now operates in a digital environment (including widespread use of smartphone apps) is key to converting willingness to pay into bottom line revenue. For carriers like Ryanair this has meant the design of enhanced personalised platforms like My Ryanair, which will enable it to leverage its strong internet presence to act as a one-stop-shop travel retailer with much greater commission based revenue potential.

Future research should provide an in-depth analysis of how such platforms can allow airlines to increase a full range of ancillary revenue categories namely: 3rd party, unbundled and FFP related revenues. It would also be an important next step to statistically model a full range of

¹ Though contrasting with the survey data, which actually showed a low willingness to pay for insurance related 3rd party products.

factors, including those highlighted in this study, that could influence passenger willingness to pay and their perceived value of purchasing 3rd party services from airlines. Though it was beyond the scope of this study's objectives, and despite not being specifically raised as an issue by the expert interviewees, future research could also look into airline-3rd party contractual relationships. The policy and regulatory frameworks overseeing these relationships could also be examined and could be designed to support and encourage the free development of such agreements whilst measuring their 3rd party service, cost and efficiency implications.

CRediT authorship contribution statement

Mark Shaw: Conceptualization, Methodology, Data collection and initial analysis. **Siobhan Tiernan:** research supervision, writing, reviewing & editing. **John F. O'Connell:** research supervision, formal analysis, writing up, reviewing & editing. **David Warnock-Smith:** Contribution to analysis and validation, writing up of journal paper, reviewing, editing and corresponding author, and submission. **Marina Efthymiou:** Writing, reviewing & editing based on various stages of feedback.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jairtraman.2020.101936>.

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