Telecom Advisory Services

A WORLDWIDE ASSESSMENT OF **SOCIO-ECONOMIC VALUE OF ULTRA-WIDEBAND**

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1. EXECUTIVE SUMMARY

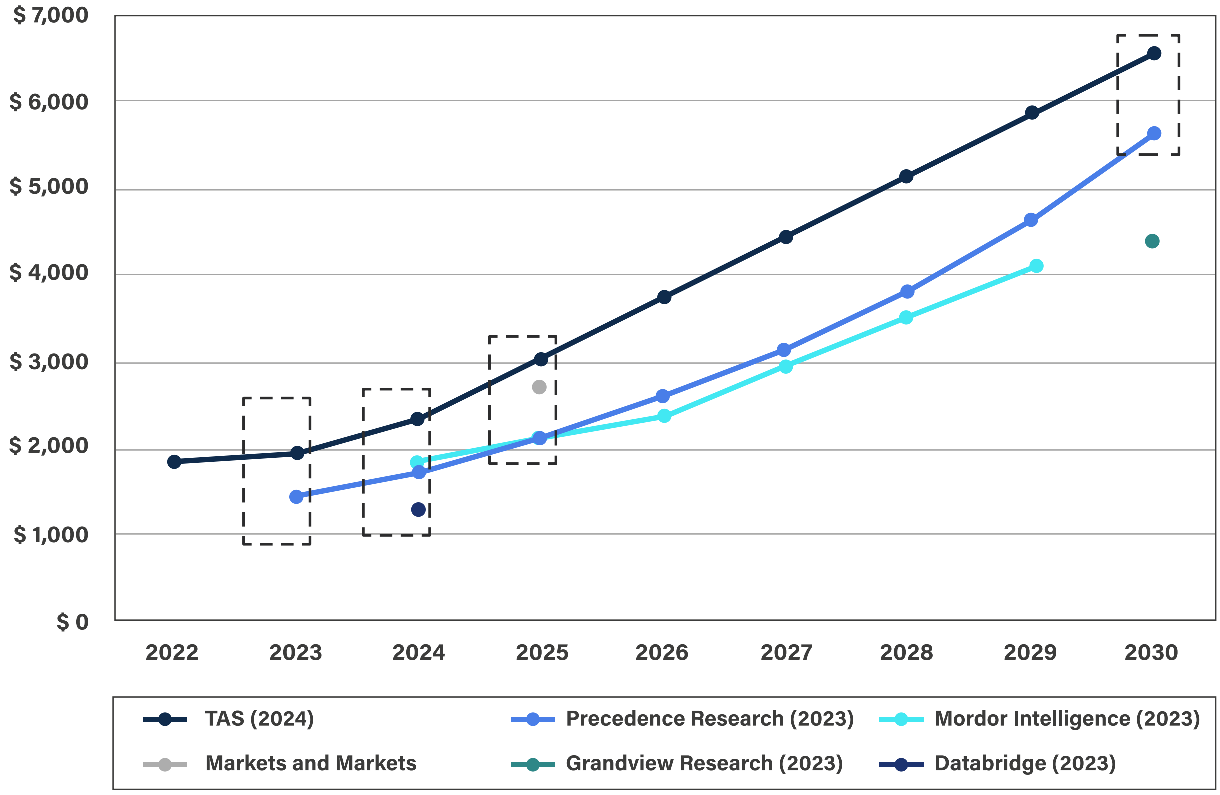
Ultra-wideband (UWB) technology has emerged as a transformative force across industries seeking precise location-tracking, robust connectivity, and efficient resource allocation. Its short-range, high-resolution capabilities support a variety of mission-critical applications, ranging from industrial automation and public transportation to consumer electronics and smart home systems. In parallel, UWB has already seen large-scale rollouts in automotive and mobile devices, with major smartphone manufacturers and carmakers integrating the technology to enable secure digital keys, proximity-based services, and occupant detection.

This study quantifies UWB's economic value by examining its contributions to Gross Domestic Product, Job Creation, Producer Surplus, and Consumer Surplus between 2022 and 2030. The Gross Domestic Product contribution is derived by consolidating all relevant revenue streams from hardware (Chipset, TAG, and Anchor [1]), software solutions, and integrated system deployments. By capturing these diverse revenue sources, the study provides a holistic snapshot of UWB's total economic footprint across many of its use cases, accounting for both the hardware market and the additional value generated through complementary software and system integration.

From a macroeconomic perspective, our study captures a broader range of UWB use cases, leading to revenue estimates that surpass other comparable forecasts. Earlier projections by consultancies were based on narrower assumptions and based on forecasts from early market development; by contrast, our analysis incorporates additional verticals—including automotive digital keys, contactless public transport payments, and integrated healthcare monitoring— and updated data, thus revealing higher overall revenues for the 2022–2030 period. (see Graphic A).

[1] *Chipset refers to the integrated circuitry enabling UWB signals; TAG is a small hardware device placed on an asset or user to track and identify them; and Anchor is the stationary reference hardware that facilitates precise positioning.*

Graphic A. Global Total UWB Revenues (2022-2030) (US$ Millions)



Source: Telecom Advisory Services analysis

A key study finding lies in the steady rise of UWB's Producer Surplus. Across industrial and retail environments, companies deploying UWB realize efficiency gains through automated inventory management, more accurate asset localization, and reduced labor costs. Over time, these annual improvements accumulate into substantive operational savings and expanded revenue opportunities, reinforcing UWB's position as a driver of innovation for both small-scale and large-scale enterprises.

On the Consumer Surplus front, end-users increasingly benefit from faster and more secure experiences—whether checking out at retail points, enabling keyless vehicle entry, or activating smart home devices with gesture-based control. Although such improvements appear incremental on a daily basis, aggregated globally they yield billions of dollars in time savings, convenience, and reduced friction in everyday tasks. The consumer adoption curve is thus tightly linked to awareness of UWB's tangible advantages, prompting device manufacturers to highlight user-facing functionalities over mere technical specifications.

In summary, between 2022 and 2030, **Gross Domestic Product** attributable to UWB is projected to grow from US$1,824.99 million to US$6,553.14 million - a compound annual growth of 17.33%, underscoring an expanding market driven by more diverse use cases and broader geographic uptake. Over the same period, **Producer Surplus** is projected to increase from US$1,878.53 million to US$15,258.64 million, as businesses achieve greater operational efficiencies and develop new revenue streams. **Consumer Surplus** is also projected to rise markedly—from US$3,114.64 million to US$14,944.24 million—mirroring the enhanced convenience and time savings experienced by end-users across mobility, retail, and smart home scenarios. Taken together, **these three areas increase the total economic impact of UWB from US$6,818.17 million in 2022 to US$36,756.02 million by the end of the decade** – a compound annual growth of 23.44 % - showcasing the technology's rapid momentum in delivering both direct economic value and widespread societal benefits (see Table A).

Table A. Global Total Economic Impact (2022-2030) (US$ Millions)

AREA	2022	2023	2024	2025	2026
Gross Domestic Product	$1,824.99	$1,929.58	$2,360.45	$3,024.95	$3,736.62
Producer Surplus	$1,878.53	$2,769.90	$3,577.11	$4,746.56	$6,354.09
Consumer Surplus	$3,114.64	$4,041.30	$4,554.33	$6,627.14	$7,245.21
Total	$6,818.17	$8,740.78	$10,491.89	$13,398.65	$17,335.92

AREA	2027	2028	2029	2030	CAGR
Gross Domestic Product	$4,436.93	$5,141.11	$5,875.68	$6,553.14	17.33%
Producer Surplus	$8,183.12	$10,301.10	$12,681.72	$15,258.64	29.93%
Consumer Surplus	$9,180.22	$11,126.52	$13,038.66	$14,944.24	21.66%
Total	$21,800.27	$26,568.73	$31,596.06	$36,756.02	23.44%

Source: Telecom Advisory Services analysis

Regional variations in UWB's economic impact reveal significant disparities in adoption and economic impact. Advanced economies like the United States and China exhibit the largest GDP contributions and employment effects, reflecting their early and comprehensive adoption of UWB solutions. Conversely, emerging markets in regions such as Africa and Latin America demonstrate slower but steady growth, highlighting the need for supportive regulatory frameworks and infrastructure development to accelerate adoption (see Table B).

Table B. UWB Economic Impact by Geography

Area	Country/Region	2022	2030	CAGR
Gross Domestic Product	United States	$483.62	$1,032.96	9.95%
	Canada	$50.04	$101.21	9.20%
	United Kingdom	$42.11	$ 139.23	16.12%
	Germany	$47.03	$189.05	18.99%
	Rest of Europe	$265.20	$925.44	16.91%
	Mexico	$7.96	$29.98	18.03%
	Brazil	$11.72	$ 50.83	20.13%
	Rest of Latin America	$16.40	$90.57	23.81%
	South Africa	$4.17	$27.62	26.64%
	Nigeria	$3.80	$ 52.26	38.78%
	Rest of Africa	$14.49	$175.82	36.61%
	Japan	$85.58	$185.67	10.17%
	South Korea	$42.87	$ 84.83	8.91%
	China (*)	$559.28	$2,485.99	20.50%
	Rest of Asia Pacific	$162.81	$856.00	23.06%
	Morocco	$2.03	$12.92	26.05%
	Saudi Arabia	$4.44	$13.60	15.02%
	Rest of Middle East and North Africa	$21.43	$99.16	21.10%
Producer Surplus	United States	$732.88	$4,644.11	25.96%
	Canada	$ 49.05	$286.64	24.69%
	United Kingdom	$83.98	$673.20	29.72%
	Germany	$93.35	$746.79	29.68%
	Rest of Europe	$431.10	$3,350.77	29.22%
	Mexico	$3.93	$14.72	17.93%
	Brazil	$0.74	$6.77	31.94%
	Rest of Latin America	$2.86	$18.43	26.22%
	South Africa	$0.29	$2.93	33.46%
	Nigeria	$0.39	$6.19	41.29%
	Rest of Africa	$1.01	$18.40	43.80%
	Japan	$61.08	$317.65	22.89%
	South Korea	$50.48	$279.60	23.86%
	China	$227.18	$3,486.74	40.69%
	Rest of Asia Pacific	$138.11	$1,387.59	33.43%
	Morocco	$0.16	$1.41	31.72%
	Saudi Arabia	$0.10	$2.08	45.80%
	Rest of Middle East and North Africa	$1.83	$14.63	29.64%
Consumer Surplus	United States	$1,704.54	$4,979.40	14.34%
	Canada	$118.96	$364.47	15.02%
	United Kingdom	$89.24	$440.19	22.08%
	Germany	$87.46	$619.99	27.74%
	Rest of Europe	$633.34	$3,793.25	25.08%
	Mexico	$1.30	$ 27.07	46.11%
	Brazil	$0.09	$30.09	105.40%
	Rest of Latin America	$1.12	$ 69.39	67.42%
	South Africa	$0.20	$21.70	80.16%
	Nigeria (**)	-$0.75	$18.43	-------
	Rest of Africa	$5.37	$232.02	60.13%
	Japan	$136.44	$432.65	15.52%
	South Korea	$84.43	$373.04	20.41%
	China	$45.74	$1,057.61	48.08%
	Rest of Asia Pacific	$ 185.95	$ 2,217.39	36.32%
	Morocco	$1.33	$23.87	43.48%
	Saudi Arabia	$2.28	$ 22.20	32.94%
	Rest of Middle East and North Africa	$17.62	$221.46	37.22%

(*) Note: China's leading position in GDP contribution primarily in 2030 is driven by its automotive production and installed base.
(**) Nigeria's consumer surplus is initially negative because the upfront acquisition costs exceed the early-stage benefit. Over time, however, as usage expands and functionality improves, the associated gains outpace these costs, resulting in a positive consumer surplus in later years.
Sources: Telecom Advisory Services analysis based on ABI Research, Techno Systems Research Co., Ltd., Organization of Motor Vehicles Manufacturers; IMF; GSMA Intelligence

Beyond these traditional measures of economic impact, UWB solutions deliver broader societal benefits through heightened safety and risk mitigation. Applications such as child presence detection in vehicles, emergency tracking for first responders, and precise monitoring of patients in healthcare facilities reduce costs associated with accidents, legal liabilities, and medical interventions. While challenging to monetize them directly in GDP calculations, these safety-driven UWB deployments represent an important complement to the productivity metrics covered in this study.

Quantifying these life-saving and injury-preventing outcomes in strict monetary terms proves challenging, as it involves assessing the value of statistical lives saved or injuries averted—methodologies that extend beyond typical GDP or surplus calculations. Nonetheless, even if these benefits remain only partially quantifiable, their role in enhancing personal safety, reducing healthcare burdens, and improving overall quality of life underscores the broader societal value that UWB delivers.

The global labor market reflects UWB's potential, with job creation occurring in both direct and indirect categories. Direct employment spans hardware manufacturing, device integration, and specialized software development, whereas indirect roles appear in supply chains and allied service industries. Induced jobs multiply as income from these sectors circulates throughout the broader economy. Accordingly, UWB's gains extend well beyond design labs and manufacturing floors, touching other segments of the global workforce (see Table C).

Table C. Global: Number of jobs-year created (2022-2030)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
Direct	7,439	8,032	9,908	12,991	16,384	19,960	23,849	27,770	33,338	159,670
Indirect	4,225	4,561	5,627	7,378	9,305	11,335	13,544	15,770	18,933	90,677
Induced	1,745	1,884	2,324	3,047	3,847	4,681	5,594	6,513	7,819	37,450
TOTAL	13,409	14,477	17,858	23,416	29,533	35,976	42,986	50,054	60,091	287,800

Note: A job-year refers to one full-time job held for a single year, as derived from input-output analysis. Each additional unit of output generated by UWB adoption translates into incremental labor demand, which, when aggregated, is expressed in job-years.
Source: Telecom Advisory Services based on input/output matrices for specific countries under analysis.

Spectrum policy emerges as a pivotal enabler of sustained UWB growth. Many jurisdictions currently permit UWB operation under tight emission masks. Industry stakeholders have advocated flexible approaches to regulating frequency allocation, mindful that advanced applications—such as multi-channel or high-precision sensing—may necessitate adjustments to permitted power levels or additional bands.

In advanced economies, UWB adoption benefits from well-established digital infrastructures, supportive regulatory frameworks, and robust consumer spending. As a result, initial deployments concentrate on consumer electronics, high-end automotive features, and large-scale industrial pilots. Nevertheless, emerging markets in Africa, Latin America, and parts of Asia Pacific are poised to experience rapid growth in UWB adoption once the foundational elements align, potentially outpacing earlier markets in terms of relative percentage increases.

Challenges remain, including ensuring device interoperability across vendors, achieving cost reductions for widespread consumer-level products, and maintaining secure data exchanges. Nonetheless, robust standardization efforts continue refining protocols to guarantee cross-platform compatibility and flexible integration. Overcoming these challenges paves the way for even broader UWB diffusion, particularly as multi-channel solutions are required for advanced industrial automation.

Looking forward, the synergy of UWB with artificial intelligence, 5G/6G connectivity, and distributed edge computing portends a phase of "context-aware automation," in which real-time location intelligence and analytics enhance everything from city infrastructure to personalized healthcare. Such convergence will likely intensify the need for careful spectrum oversight while simultaneously unlocking still-untapped potential in advanced driver-assistance systems, autonomous robotics, and extended reality environments.

In sum, UWB technology stands as a foundational pillar of next-generation connectivity and location services, fostering quantifiable gains in economic output, job creation, and consumer welfare. UWB has already established a wide-ranging commercial footprint across multiple sectors. Future success hinges on maintaining balanced regulatory support, investing in standardization, and continuing to educate both enterprises and end-users about UWB's tangible benefits in convenience, security, and societal well-being.

1. INTRODUCTION

Ultra-wideband (UWB) is a short-range, wireless technology that relies on unlicensed high frequency spectrum, typically in the 6 GHz to 10 GHz bands, to support applications and use cases requiring accurate positioning and high security for ranging applications. Market development statistics already depict high demand for UWB-enabled devices[1], indicating its rising prominence in areas such as smart homes, mobility, industrial processes, and public transportation. In this context, potential regulatory changes in areas such as spectrum management and deployment flexibility could accelerate use case adoption. Accordingly, the purpose of the following report is to provide a rigorous assessment of UWB's social and economic value as background for the critical importance of potential changes in the regulatory framework guiding UWB applications.

Contrary to licensed bands where economic value could equate to whatever is paid at auction, the economic value of unlicensed spectrum, such as UWB, needs to be measured based on the concept of economic surplus, and measured in four areas: (i) increase in producer surplus triggered by a reduction of an enterprise capital expenditures (CAPEX) and operating expenses (OPEX) resulting from UWB adoption, (ii) increase in consumer surplus measured as the incremental value perceived by consumers, (iii) contribution to GDP[2], and (iv) consequent job creation. The quantitative estimates presented in this report are reported both in global terms and disaggregated by geography.

The report is structured as follows. Chapter 2 presents a review of the existing research literature on UWB and identifies gaps in current UWB economic literature, emphasizing the need for a comprehensive study covering GDP, producer surplus, and consumer surplus. Chapter 3 details the theoretical framework and methodology relied upon for measuring UWB social and economic value. On this basis, Chapter 4 presents the general study results on an aggregated basis while Chapter 5 provides an interpretation of results. Chapter 6 presents the study results disaggregated by country and regions. Finally, Chapter 7 summarizes the study findings and draws their policy implications.

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[1] According to ABI Research, the number of UWB- enabled devices shipped globally will grow from 109 million devices in 2019 to over 1 billion by 2025 (see Zignani, A. and Tomsett, S. (2021). *UWB for the IoT – a fine ranging revolution?* Retrieved in: https://www.allaboutcircuits.com/uploads/articles/UWBWP.pdf

[2] By including the GDP contribution measurement, we follow Greenstein et al. (2010) and prior literature measuring the economic gains of new goods. On the one hand, we focus on consumer and producer surplus, but, on the other hand, we consider the new economic growth enabled by UWB. In measuring the GDP direct contribution, we strictly consider the revenues added "above and beyond" what would have occurred had the UWB spectrum been licensed.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

UWB technology has evolved from its origins in pulse-based radar and niche sensing applications to a versatile wireless platform enabling high-precision location, robust data links, and mission-critical functionalities. Over the past few years, mass deployments of UWB in mobile and vehicular devices—such as digital car keys and precise indoor navigation systems—have underscored its shift from theoretical explorations toward widespread commercial adoption. This transition is fueling new use cases in consumer electronics, industrial automation, and mobility services, while simultaneously prompting policymakers and industry stakeholders to re-examine the regulatory frameworks that govern frequency allocation and system interoperability.

Despite its rapidly expanding presence, the broader economic contributions of UWB remain relatively underexplored. Research has historically focused on engineering breakthroughs without fully addressing UWB's potential to drive GDP growth, enhance productivity, and generate surpluses for both producers and consumers. The following chapter addresses these aspects through two main sections. Section 2.1 outlines the macroeconomic models used to evaluate how emerging technologies, including UWB, influence key indicators such as output, employment, and consumer welfare. Section 2.2 then discusses critical research gaps, highlighting the need for a more comprehensive theoretical lens to capture UWB's unique capabilities and the broader motivation for assessing its socio-economic value beyond traditional engineering metrics.

2.1. Economic Impact of Emerging Technologies

Macroeconomic discussions frequently emphasize how emerging technologies alter economic productivity and shape overall growth. Solow (1957) laid the groundwork by arguing that technological innovations—encompassed in what he termed "technical progress"—significantly account for variance in a country's long-term output growth. This perspective has since been refined, leading scholars to develop diverse frameworks for gauging how breakthroughs, such as artificial intelligence, blockchain, and new wireless paradigms, contribute to GDP and employment.

Considering technology solutions often require specialized frameworks that encompass intangible assets like data, software platforms, and innovation ecosystems. Corrado et al. (2009) emphasize that knowledge capital—patents, trademarks, and software—accounts for a growing share of value creation in modern economies. Therefore, measuring the economic impact of emerging technologies demands analytic methods that can capture these intangible contributions, which do not always appear neatly in standard national accounts.

Beyond production-side frameworks, consumer surplus and societal welfare also factor into the comprehensive evaluation of emerging technologies' contribution to economic performance. Goolsbee and Klenow (2006) propose methods that incorporate consumer welfare gains from digital platforms, many of which offer free or low-cost services that elevate living standards without substantially appearing in official GDP statistics. This consumption-based perspective is key in evaluating, for instance, how IoT or UWB solutions might enhance logistics and daily living convenience.

Beyond these high-level macroeconomic frameworks, literature on the economic valuation of unlicensed spectrum points to practical methods that could be adapted for UWB. Since Coase (1959), economists and policymakers have debated optimal spectrum allocation strategies, especially for unassigned or "commons" frequencies. The history of Wi-Fi provides a useful blueprint for assessing the producer surplus, consumer surplus, and potential GDP contributions that can emerge when spectrum remains unlicensed or flexibly managed.

Early attempts to quantify Wi-Fi's economic value include Thanki (2009), who estimated that three key applications—residential Wi-Fi, hospital Wi-Fi, and RFID in retail—generated between $16 and $36.8 billion in annual value in the United States alone. While those figures were conservative, subsequent studies such as Milgrom et al. (2011) identified additional components of value, including faster data services, cellular off-loading, and the growing ecosystem of Wi-Fi–dependent devices like tablets and smartphones.

Later analyses by Thanki (2012), Cooper (2012), and Katz (2014, 2018, 2020, 2024) refined these approaches by including an expanded set of use cases and calculating both consumer and producer surplus, as well as indirect benefits like cost avoidance for cellular carriers. Though these studies primarily target Wi-Fi, the underlying methodologies are equally applicable to UWB. Similar to Wi-Fi, UWB's combination of robust connectivity and advanced sensing could spur new devices, services, and organizational practices that generate both direct and spillover economic gains.

Such adaptions would track consumer and producer surpluses specific to UWB-enabled applications, whether for indoor localization, presence detection, health monitoring, or industrial automation. By following the precedent set in Wi-Fi studies researchers can more reliably approximate the total economic impact of UWB. This aligns with the broader macro-level models described above, solidifying UWB as a noteworthy driver of productivity, employment, and long-term GDP growth.

2.2. Research Gap and theoretical motivation for the study

Despite the engineering strides outlined earlier, there remains a relative dearth of research examining how UWB diffusion might shape broader economic indicators like GDP or employment. Previous studies in related domains, such as those by Thanki (2009), Milgrom et al. (2011) and Katz (2014, 2018, 2020, 2024) for Wi-Fi, underscore that wireless innovations can yield substantial consumer and producer surpluses, alongside indirect benefits like innovation spillovers. However, the existing UWB-focused scholarship, while robust on technical dimensions such as pulse design, multi-static networks, and device-free localization, provides only limited insights into the macroeconomic gains potentially unlocked by UWB's widespread deployment.

A central theoretical challenge stems from the need to quantify intangible assets within UWB's domain. Corrado et al. (2009) argue that intangible capital—software, patents, and brand equity—often contributes substantially to economic value in advanced industries. Although the technical literature on UWB alludes to proprietary algorithms, patent portfolios, and specialized chipsets, there is scant evidence of systematic attempts to translate these innovations into monetary valuations or to connect them with aggregated productivity metrics. This gap restricts policymakers' ability to weigh the costs of regulatory or infrastructure decisions against long-term societal returns.

Another impediment is that frameworks for measuring indirect welfare enhancements—especially consumer surplus—have rarely been applied to UWB contexts. Goolsbee and Klenow (2006) highlight the importance of accounting for low-cost services and enhancements in daily convenience. Yet few UWB studies have ventured beyond pilot projects to assess the utility gains for end-users, whether in healthcare, security, or automotive domains. Without these assessments, the technology's consumer-facing advantages remain anecdotal, hindering a full comprehension of UWB's societal footprint.

Relatedly, the synergy between technical and economic analyses warrants attention. Solow (1957) emphasized the role of "technical progress" in explaining a nation's output growth, but the UWB community has not thoroughly adopted such macroeconomic lenses. Adapting Wi-Fi's economic valuation methods—per Thanki (2009, 2012) and Cooper (2012)—to UWB would fill this void. By systematically mapping UWB use cases (e.g., indoor localization, industrial process automation, and healthcare monitoring) to specific metrics (e.g., time saved, cost avoided, productivity gained), it becomes more feasible to derive reliable estimates of cumulative economic contributions. This is the focus on the present study. In sum, a pronounced gap exists at the intersection of UWB's technical maturity and its economic significance. Researchers have ample motivation to extend the frameworks previously employed for Wi-Fi into the UWB sphere, estimating producer and consumer surpluses, and aggregating them into macroeconomic results (including the effect on Gross Domestic Product and employment). Such efforts would bridge the current divide between rigorous engineering experiments and nascent economic theories, ultimately offering stakeholders a more holistic vision of UWB's potential to enrich global markets and society at large.

3. METHODOLOGY

This study aims to evaluate the socio-economic impacts of UWB technology by examining three key dimensions: its contribution to Gross Domestic Product (GDP), producer surplus, and consumer surplus. Together, these metrics offer a comprehensive framework to assess both the economic and societal benefits arising from the adoption of UWB across a broad range of applications, including smart homes, mobility, industrial activities, and public transportation. The methodological approach adopted herein is designed to capture both the immediate and longer-term effects of UWB, thus providing a robust foundation for understanding its overall economic significance.

The first dimension of analysis is the contribution of UWB technology to GDP, which is evaluated as the total revenues generated through the deployment and use of UWB-enabled technologies and services. This measure provides an aggregate view of the economic activity facilitated by UWB adoption. Importantly, the concept of GDP in this context implicitly includes producer surplus, traditionally defined as the difference between the revenues received by producers and the costs incurred in production. While this definition captures the immediate economic gains for producers, the study expands its scope to separately examine productivity enhancements, which represent a more nuanced and longer-term perspective on producer surplus. Furthermore, this dimension (GDP) goes beyond output and revenue growth by employing input-output matrices to assess the employment effects associated with UWB implementation. Through this approach, the methodology underscores UWB's role in job creation, thereby providing a richer and more holistic understanding of its macroeconomic influence.

The second dimension focuses exclusively on evaluating producer surplus from the perspective of productivity gains enabled by UWB technology[3]. This approach emphasizes the cost reductions, efficiency improvements, and operational enhancements that UWB adoption fosters across various sectors, such as industrial processes and smart retail. By concentrating on these long-term impacts, the study highlights how UWB technology drives value creation, offering a deeper understanding of its transformative potential for producers.

Finally, the third dimension examines consumer surplus, focusing on the additional value users gain from UWB-enabled applications. In this document, consumer surplus is quantified by translating improvements in convenience, security, and efficiency into measurable benefits, such as time savings, reduced effort, or lower costs. The analysis evaluates these gains across various domains—including smart homes, mobility, public transportation, and smart buildings—by estimating the hours saved, the potential productivity of that freed time, and the cost reductions realized through UWB-based functionalities. By applying a conservative approach to user adoption rates and productivity assumptions, the study provides a structured, data-driven estimate of the societal advantages derived from widespread UWB adoption.

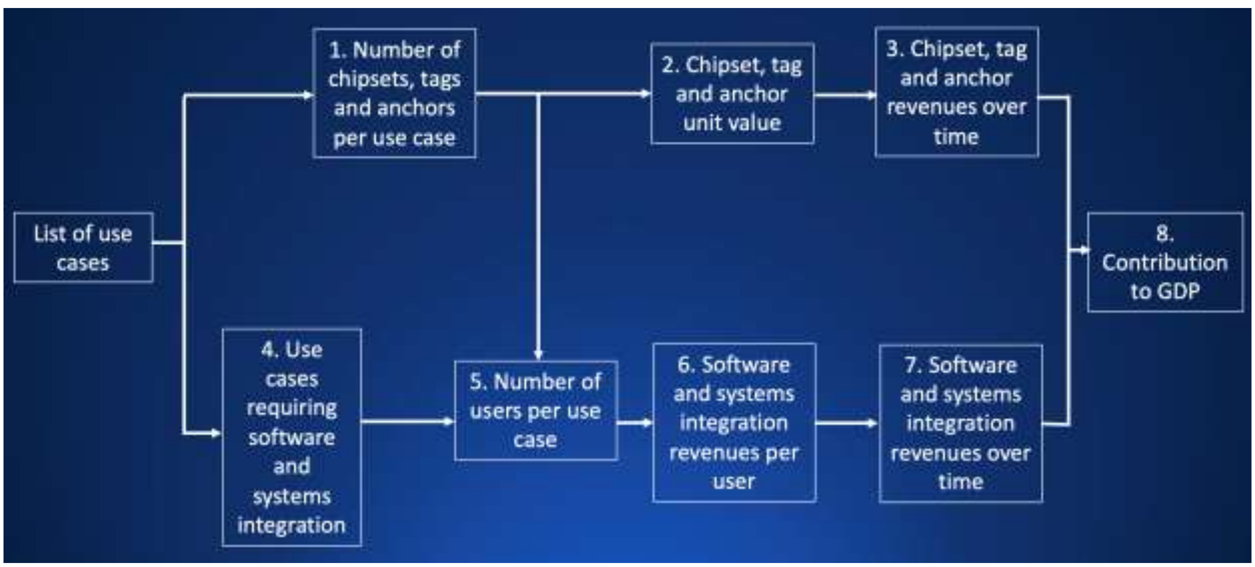
[3] These productivity-driven efficiencies represent incremental gains beyond the basic producer surplus that's implicitly captured in the GDP measure, ensuring they are not double-counted.

Through these three dimensions, this methodology establishes a structured and rigorous approach to quantify the socio-economic value of UWB technology. Each of these aspects will be explored in greater detail in subsequent sections.

3.1. Measuring GDP Contribution

The methodology for assessing the GDP contribution of UWB technology is built upon a structured framework that quantifies the revenues generated across seven primary application areas: Smart Home, Mobility, Individual Consumer, Smart Retail, Industrial, Public Transportation, and Smart Building. This section offers a detailed explanation of the approach, outlining the steps used to estimate revenue contributions for each use case and region. By focusing on two main revenue streams—Chipset, TAG and Anchor sales, and Software and System Integration—this methodology delivers a thorough evaluation of UWB's economic impact (see Figure 3-1).

Figure 3-1. Methodology for estimating GDP contribution



Source: Telecom Advisory Services analysis

The first step involves estimating the number of users for each use case within the seven application areas. This analysis relies on data sources such as Techno Systems Research Co., ABI Research, and proprietary forecasts developed by Telecom Advisory Services. These sources provide comprehensive projections for adoption rates of UWB-enabled use cases. Adoption rates are expressed as the estimated number of devices, systems, or services expected to incorporate UWB technology over a defined timeframe (2018-2030). Understanding these rates is essential to gauge the market size and potential for each use case.

In the second step, the methodology determines the unit revenue associated with each identified use case. This involves distinguishing between two principal revenue streams—

Chipset, TAG, and Anchor sales, and Software and System Integration—while noting that all use cases include some measure of integration-related revenue. For hardware-intensive scenarios (e.g., UWB-enabled anchors or tags), the methodology calculates per-user unit revenues based on hardware components. In parallel, it assigns software and system integration revenues for every use case, utilizing estimates derived from a targeted survey conducted with key industry stakeholders to ensure realistic assessments. By rigorously defining these unit revenues, drawing on both empirical data and sectoral expertise, the approach guarantees that subsequent calculations rest on accurately represented value streams.

The third step integrates the outcomes of the first two stages. Multiplying the number of users in a given use case by the respective unit revenues (differentiated by hardware and software integration) yields that use case's total revenue contribution. Repeating this calculation across all use cases and aggregating them within each application area results in a comprehensive revenue profile by sector. For example, under Smart Retail, the UWB-enabled drone-controlled delivery use case combines hardware (Chipset, TAG, and Anchor) sales with revenues derived from the software and system integration necessary for seamless operations, thus offering a formalized estimate of total economic value.

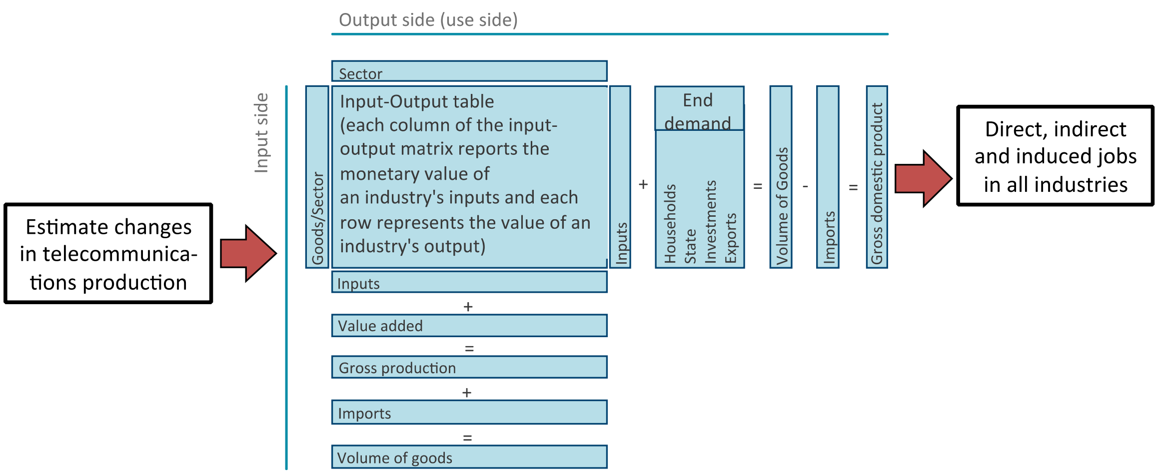
Once global revenue estimates are obtained for each application area, the approach proceeds to regionalize these figures. Guided by sector-specific distribution criteria, this stage ensures that the analysis reflects the nuanced geographical differences in adoption patterns and market dynamics. Smartphone-related use cases, for instance, rely on adoption data from GSMA Intelligence, while vehicle-related use cases employ vehicle sales data sourced from the International Organization of Motor Vehicle Manufacturers (OICA). For industrial use cases, regional allocations lean on GDP projections from the International Monetary Fund (IMF). This geographic tailoring highlights where UWB technology is likely to have the greatest impact, allowing stakeholders to pinpoint regions and markets with the highest growth potential.

After consolidating these calculations, the methodology provides a global estimate of UWB's GDP contribution, detailing contributions by both sector and region. The resulting metrics present an accurate estimation of where UWB technology is generating substantive economic benefits. These findings, grounded in robust data sources and transparent calculations, deliver reliable insights to stakeholders aiming to maximize the socio-economic gains associated with UWB.

A crucial element of this analysis is the incorporation of producer surplus in its classical sense—i.e., the difference between producers' revenues and production costs—as an implicit component of GDP. By capturing the financial gains that manufacturers, service providers, and integrators realize through UWB adoption, the methodology reflects immediate economic benefits flowing through the UWB value chain. This step further sets the stage for a separate, detailed examination of productivity-driven producer surplus in the subsequent section.

Beyond output and revenue growth, the methodology also addresses UWB's implications for job creation, recognizing that technological adoption can generate ripple effects throughout the economy. Utilizing input-output (I/O) matrices, the study evaluates how increases in telecommunications-related output—spurred by UWB adoption—transmit through interconnected sectors to stimulate job creation. I/O tables, which represent how outputs from some sectors serve as inputs into others, enable a rigorous estimation of direct, indirect, and induced employment effects. Grounded in previously established work (such as Katz, 2012), this approach allows for a more complete understanding of how UWB-driven growth can foster broader socio-economic benefits, including new employment opportunities (see Figure 3-2).

Figure 3-2. Example of an Input / Output Table



Source: Katz (2012)

This methodology, which evaluates the interdependencies among an economy's diverse productive sectors, has been employed to estimate how changes in the telecommunications sector's output affect employment across all industries. Under this approach, telecommunications output related to UWB is treated as a factor of production for other goods and services, thereby generating substantial spillover effects and contributing significantly to job creation.

- Employment effects are calculated based on I-O table for each country's economy. I-O tables depict the interdependencies between economic sectors and are used to estimate the impact of positive or negative economic shocks through an economy.

- I/O tables assume that some inputs are used by sectors that produce output (intermediate output), which in turn is sold to another sector for consumption (final output); total output adds intermediate and final outputs. By using labor productivities, one can calculate job creation from output.

The structure of an I/O table comprises horizontal rows describing how an industry's total output is divided among various production processes and final consumption, and each column denotes the combination of productive resources used within one industry. Each country has a specific table to reflect the particularities of its economy. In order to calculate employment impact, the multiplier cumulative impact on GDP resulting from the effects analyzed above, would become an input that would generate employment effects through different sectors of the economy of the country under study. Employment effects can be disaggregated among direct, indirect, and induced.

In sum, this integrated and comprehensive methodology illuminates the full spectrum of UWB's economic influence. By quantifying total revenues and output, accounting for regional disparities, embedding classical producer surplus, and employing I/O matrices to capture employment effects, it offers a multidimensional view of UWB's GDP contribution. This level of detail not only enhances the precision and contextual relevance of the assessment but also underscores UWB's transformative potential to shape the global economy.

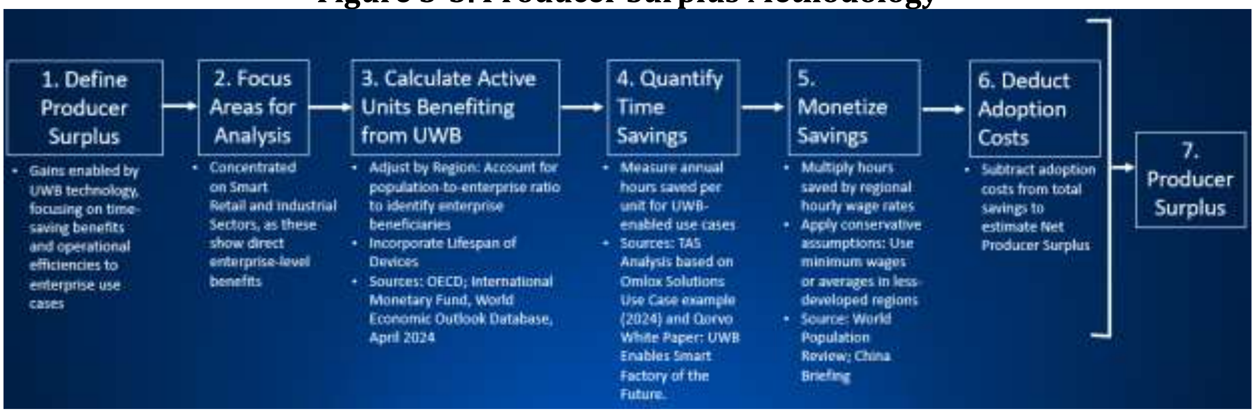
3.2. Assessing Producer Surplus

Producer surplus, in its classical sense, represents the difference between the revenues producers receive and the costs incurred in generating those revenues. This traditional perspective has already been accounted for in the GDP contribution analysis presented in Section 3.1, which captures the immediate financial gains for producers of UWB-enabled products and services. However, producer surplus can also be analyzed from the perspective of productivity gains—enhancements in efficiency and resource utilization enabled by UWB technology. This broader definition focuses on the operational and time-saving benefits that UWB adoption delivers to enterprises, reflecting its transformative potential beyond direct revenue impacts.

For this analysis, we concentrate on two of the seven primary application areas: **Smart Retail** and **Industrial**. These sectors are particularly relevant for assessing productivity-driven producer surplus, as UWB technology directly enhances operational efficiency in these contexts. The remaining five areas—Smart Home, Mobility, Individual Consumer, Public Transportation, and Smart Building—will be addressed under consumer surplus, where the benefits primarily accrue to end-users rather than producers. In contrast, Smart Retail and Industrial applications enable measurable productivity improvements for enterprises, making them ideal candidates for this analysis.

The methodology for estimating productivity-driven producer surplus involves quantifying the time savings enabled by UWB technology and monetizing these savings using average hourly income. The first step involves estimating the number of users in each use case area. Unlike the revenue analysis in the GDP chapter (chapter 3.1), where the focus is on annual sales, this section emphasizes the active units benefiting from UWB adoption. To achieve this, the number of users previously identified in the revenue analysis is adjusted by accounting for the region-specific ratio of individuals to enterprises, as the beneficiaries in this context are primarily businesses. Additionally, the active units include not only the current year's sales but also the technologies still in use from prior years, determined by their expected lifespan and replacement rates. Once the number of beneficiaries is estimated, the next step involves calculating the annual hours saved per unit, which are detailed in subsequent sections (3.2.1 and 3.2.2). These hours are then multiplied by the hourly wage of each region to derive the total economic benefit. This comprehensive approach captures the temporal and geographic dimensions of productivity gains enabled by UWB adoption, providing a robust foundation for quantifying producer surplus (See Figure 3-3).

Figure 3-3. Producer Surplus Methodology



Source: Telecom Advisory Services analysis

The first step in estimating productivity-driven producer surplus involves refining the number of users identified in Chapter 3.1 for each use case area by adjusting for the population-to-enterprise ratio in each region. This adjustment is critical as the producer surplus focuses on benefits accrued to enterprises, not individual consumers. By applying the region-specific ratio of enterprises to the total population, the methodology ensures that only the relevant share of users contributing to enterprise productivity is considered. This adjustment is performed for each use case, leveraging data presented in Table 3-1. The resulting enterprise-adjusted user count serves as the basis for further calculations of active units benefiting from UWB-driven productivity enhancements.

Table 3-1. Estimation of relationship between number of enterprises and population

Country/ Region	Population / Enterprises	Enterprises (M)	Year	Source	Population (M)	Year	Source
United States	10	33.19	2023	US Census Bureau. Only small firms (but represents 99.9% of firms). https://www.countrybank.com/support-small-business-saturday-november-30th-a-celebration-of-local-entrepreneurs/	335.14	2023	International Monetary Fund, World Economic Outlook Database, April 2024
Canada	9	4.09	2020	OECD - OECD.BSES.ENTR	38.00	2020	International Monetary Fund, World Economic Outlook Database, April 2024
United Kingdom	10	6.47	2019	OECD - OECD.BSES.ENTR	66.80	2019	International Monetary Fund, World Economic Outlook Database, April 2024
Germany	12	6.81	2020	OECD - OECD.BSES.ENTR	83.16	2020	International Monetary Fund, World Economic Outlook Database, April 2024
Rest of Europe region	11	Estimated as the average value of data from the United Kingdom and Germany					
Mexico	6	18.64	2013	OECD - OECD.BSES.ENTR	119.60	2023	International Monetary Fund, World Economic Outlook Database, April 2024
Brazil	14	14.19	2020	OECD - OECD.BSES.ENTR	200.98	2020	International Monetary Fund, World Economic Outlook Database, April 2024
Rest of Latin America	10	Estimated as the average value of data from Mexico and Brazil					
South Africa	15	4.00	2023	CODERA https://codera.co.za/how-many-businesses-are-there-in-south-africa/#:~:text=At%20around%203.2%20million%2C%20these,expected%20to%20submit%20tax%20returns	61.53	2023	International Monetary Fund, World Economic Outlook Database, April 2024
Nigeria	5	39.70	2020	World Bank; http://documents1.worldbank.org/curated/en/099055202202331735/pdf/IDU0ff38186304ab204c9209dd1037aeeb43b3d8.pdf	206.14	2020	International Monetary Fund, World Economic Outlook Database, April 2024
Rest of Africa	10	Estimated as the average value of data from South Africa and Nigeria					
Japan	10	13.30	2016	OECD - OECD.BSES.ENTR	126.96	2016	International Monetary Fund, World Economic Outlook Database, April 2024
South Korea	7	7.17	2018	OECD - OECD.BSES.ESTB	51.59	2018	International Monetary Fund, World Economic Outlook Database, April 2024
China	8	169.00	2020	STATISTA	1412.12	2020	International Monetary Fund, World Economic Outlook Database, April 2024
Rest of Asia Pacific	8	Estimated as the average value of data from Japan, South Korea and China					
Morocco	25	No data for number of enterprises. Estimated, using the same value of data from Saudi Arabia					
Saudi Arabia	25	1.31	2023	https://www.argaam.com/en/article/articledetail/id/1709526	32.82	2023	International Monetary Fund, World Economic Outlook Database, April 2024
Rest of Middle East and North Africa	25	Estimated, using the same value of data from Saudi Arabia					

Sources: Telecom Advisory Services analysis based on OECD; International Monetary Fund; STATISTA and local data sources.

The second step in calculating active units benefiting from UWB adoption involves accounting for the lifespan of devices across different use cases. This step ensures that the analysis captures not only the current year's sales but also the devices still in operation from prior years. The estimated duration of use for each device type is based on typical replacement cycles, as outlined in Table 3-2, which considers factors such as technological advancements, maintenance requirements, and operational reliability. For instance, tap-free mobile payment systems are assumed to have a 2-year lifespan, while industrial real-time location systems are allocated a 4-year duration due to their robust design and industrial-grade performance requirements. It is important to note that these durations are intentionally conservative, as the actual lifespan of devices in many use cases is often longer. This approach ensures a prudent baseline while acknowledging that the benefits may extend beyond the assumed replacement cycles, thus potentially underestimating the total active units benefiting from UWB-driven productivity enhancements.

Table 3-2. Estimation of replacement cycles by UWB area

Area	Duration (Years)	Explanation
Tap-free mobile payment	2	A 2-year lifespan aligns with the typical upgrade cycle of mobile devices and payment systems, ensuring security features remain up-to-date and compatible with new payment technologies.
Unmanned store access	4	Access control systems in unmanned stores require durable devices to minimize maintenance. A 4-year period ensures reliable performance with minimal disruptions.
Foot traffic and shopping behavior analytics	3	Analytics systems benefit from regular updates to maintain data accuracy and integrate new analytical tools, making a 3-year renewal cycle optimal for sustained performance.
Exhibition attendee management	2	Exhibitions often require flexible and up-to-date management solutions. A 2-year lifespan allows for adapting to changing event requirements and attendee management technologies.
Targeted marketing	3	Marketing strategies and technologies evolve rapidly. Renewing devices every 3 years ensures that targeted marketing efforts remain effective and leverage the latest UWB capabilities.
Drone controlled delivery	3	Drone operations demand reliable and robust devices. A 3-year lifespan balances the need for durable hardware with the advancements in drone technology, ensuring consistent delivery performance.
In-vehicle payment	3	In-vehicle payment systems need to stay secure and integrate with evolving automotive technologies. A 3-year renewal cycle ensures continued compatibility and security.
Indoor navigation	3	Indoor navigation infrastructures benefit from longer device lifespans to reduce frequent replacements, while still allowing for updates to navigation algorithms and infrastructure changes.
Proximity-based patient data sharing	2	Healthcare environments require up-to-date security and compliance features. A 2-year renewal cycle ensures patient data sharing systems remain secure and adhere to the latest regulations.
Teleconference system	3	Teleconference systems benefit from regular updates to support new features and maintain high performance. A 3-year lifespan ensures the system stays current with technological advancements.
Patient tracking	2	Accurate and reliable patient tracking is critical in healthcare settings. A 2-year renewal cycle ensures devices remain precise and incorporate the latest tracking technologies.
Industrial Real Time location Systems	4	Industrial environments require highly durable and long-lasting devices to support continuous operations. A 4-year lifespan minimizes downtime and maintenance costs while ensuring robust performance.

Source: Telecom Advisory Services analysis

The final step in estimating productivity-driven producer surplus involves quantifying the annual hours saved per unit and monetizing these savings based on regional wage levels. The annual hours saved are calculated for each use case, as detailed in subsequent sections (3.2.1 and 3.2.2), capturing the specific time efficiencies enabled by UWB technology. These saved hours are then multiplied by the hourly wage or salary of each region to derive the total economic benefit. As a rule, for advanced economies, the minimum wage is applied to ensure conservative estimates. Conversely, in less developed economies, a multiple of the minimum wage closer to the average salary is used. This adjustment better reflects the remuneration levels of the more advanced enterprises, which are the most likely adopters of UWB technology in less developed economies. Firms in less developed regions with lower wages often face weaker incentives to adopt high-cost technologies, as the cost-to-benefit ratio is less favorable for them. This approach ensures that the estimated producer surplus aligns with the economic profiles of the firms most likely to drive UWB adoption. Table 3-

3 provides the specific wage rates applied for each region, supporting the calculations of the total economic impact.

Table 3-3. Salary per hour by country/region

Country/ Region	Salary per hour (US$)	Source
United States	$ 16.00	The minimum wage of California was taken as a reference for the United States.
Canada	$ 11.60	Minium salary. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
United Kingdom	$ 14.27	Minium salary. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Germany	$ 14.68	Minium salary. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Rest of Europe region	$ 14.48	Estimated as the average value of data from the United Kingdom and Germany
Mexico	$ 3.60	In this country, twice the minimum wage is often considered a standard benchmark, as companies adopting technology tend to be associated with industries offering higher salaries. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Brazil	$ 2.98	In this country, twice the minimum wage is often considered a standard benchmark, as companies adopting technology tend to be associated with industries offering higher salaries. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Rest of Latin America	$ 3.29	Estimated as the average value of data from Mexico and Brazil
South Africa	$ 3.14	In this country, twice the minimum wage is often considered a standard benchmark, as companies adopting technology tend to be associated with industries offering higher salaries. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Nigeria	$ 1.29	In this country, trhee times the minimum wage is often considered a standard benchmark, as companies adopting technology tend to be associated with industries offering higher salaries. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Rest of Africa	$ 2.22	Estimated as the average value of data from South Africa and Nigeria
Japan	$ 8.14	Minium salary. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
South Korea	$ 11.50	Minium salary. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
China	$ 3.70	Based on Beijing minium salary. https://www.china-briefing.com/news/minimum-wages-china/#:~:text=Minimum%20wages%20in%20China%20continue%20to%20rise.,%2FUS%243.7%20per%20hour).
Rest of Asia Pacific	$ 7.78	Estimated as the average value of data from Japan, South Korea and China
Morocco	$ 5.25	In this country, trhee times the minimum wage is often considered a standard benchmark, as companies adopting technology tend to be associated with industries offering higher salaries. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Saudi Arabia	$ 5.13	Minium salary. https://worldpopulationreview.com/country-rankings/minimum-wage-by-country
Rest of Middle East and North Africa	$ 6.05	Estimated as the average value of data from Morocco and Saudi Arabia

NOTE: While the wage figures listed here reflect conservative baseline values (e.g., minimum wages or twice the minimum wage in certain geographies), actual salaries in high-tech or industries are often substantially higher. This conservative approach helps ensure we do not overstate the estimated productivity gains tied to UWB adoption.

Sources: Telecom Advisory Services analysis based on World Population Review and local sources.

While the productivity savings estimated above reflect significant operational efficiencies enabled by UWB technology, it is important to recognize that these savings must be adjusted to account for the costs incurred by enterprises in adopting UWB systems. Specifically, the producer surplus is derived by deducting the revenues generated from UWB-enabled products and services—already estimated in the GDP analysis—from the total productivity gains in each sector. This adjustment ensures that the net surplus reflects the true value added to enterprises after accounting for the costs associated with purchasing and implementing UWB technologies.

By aggregating these productivity savings across all relevant use cases in the Smart Retail and Industrial sectors, we arrive at a robust estimate of producer surplus from UWB-enabled productivity gains. This methodology provides a clear and reliable framework for quantifying the operational efficiencies delivered by UWB technology. It highlights the significant economic value created for producers, complementing the consumer-focused analysis conducted in other areas. Through this approach, we underscore the transformative impact of UWB technology in driving efficiency, reducing costs, and enhancing productivity across critical sectors of the economy.

3.2.1. Productivity Savings in the Smart Retail Sector

The Smart Retail sector presents a wide range of opportunities for productivity improvements through UWB technology. By enhancing efficiency in processes such as payments, customer behavior analytics, and logistics, UWB transforms traditional retail operations. This section evaluates seven key use cases—tap-free mobile payment, unmanned store access, foot traffic and shopping behavior analytics, exhibition attendee management, targeted marketing, drone-controlled delivery, and in-vehicle payment—and quantifies their associated productivity savings. We adopt a conservative approach, estimating time savings of up to 15% to reflect achievable and realistic operational improvements.

Also, in all analyses, we standardize the estimation of annual working days to ensure consistency. Starting with the total number of days in a year (365 or 366 for a leap year), we subtract weekends, which account for 104 days (52 weeks × 2 weekend days per week), leaving 261 potential working days. From this, we deduct public holidays, assumed to be 15 days on average, based on variations across countries. This adjustment reduces the total to 246 working days. Lastly, a standard two-week vacation (10 days) is subtracted, resulting in approximately 236 effective working days in a typical year. This framework provides a realistic baseline for calculating productivity gains across all use cases.

Tap-Free Mobile Payment is a critical innovation enabled by UWB technology, offering significant improvements to the checkout process by eliminating delays associated with traditional payment methods such as card swiping or QR code scanning. This system leverages precise, secure, proximity-based payments to reduce transaction times and enhance customer throughput. To calculate the potential savings, we assume that a typical retail cashier processes at least an average of 50 transactions daily, with each transaction taking approximately 1 minute[4]. This translates into 50 minutes of daily time spent on payment processing. However, it is important to recognize that not all customers will be using UWB technology (we assume that only 5 can be attributed to UWB-enabled payments). Taking this into account, and applying a conservative time reduction estimate of 10%, the annual savings for a cashier amount to approximately 0.98 hours per year. This enhanced

[4] The average number of transactions a cashier handles per hour in a grocery store ranges from 20 to 30, depending on factors like transaction complexity and checkout efficiency. Assuming a cashier works an 8-hour shift, this results in approximately 160 to 240 transactions per day. Therefore, estimating 50 transactions daily per cashier is a conservative figure, accounting for variations in store traffic and shift lengths.

efficiency improves customer throughput and reduces queues, particularly during peak hours.[5]

Unmanned Store Access leverages UWB technology to automate customer entry, product selection tracking, and checkout processes, reducing the need for staff intervention. Traditionally, these tasks involve significant manual effort, such as unlocking doors, monitoring customer activity, and processing payments. By automating these processes, UWB delivers notable time savings and operational efficiencies. To estimate the potential savings, we assume that store operations involve approximately 7 hours of manual labor daily for tasks such as entry control and checkout[6]. However, it is crucial to acknowledge that not all customers will interact with UWB-enabled systems. Adopting a conservative approach, we estimate that only 10% of this daily time can be attributed to UWB-enabled activities. Applying a 10% reduction in time spent on these tasks due to UWB technology results in an annual savings of approximately 16.52 hours per store. These estimates are intentionally conservative, reflecting realistic adoption rates and achievable efficiency improvements. Even with these cautious assumptions, the operational benefits of UWB are evident, particularly in high-traffic locations or during off-peak hours, when fewer staff are available. This innovation enables retailers to optimize resources and improve the overall shopping experience by streamlining store operations.[7]

Foot Traffic and Shopping Behavior Analytics are significantly enhanced through UWB technology, which enables precise, real-time insights into customer movements and behaviors. Traditionally, these insights require manual observation or camera-based systems that involve extensive data processing, often leading to inefficiencies and delays in decision-making. UWB technology automates these processes, offering more accurate and actionable analytics. To estimate the potential savings, we assume that retail analytics personnel typically spend around 7 hours daily analyzing customer behavior and foot traffic data using conventional methods. Taking a conservative approach, we estimate that only 10% of this daily effort can currently be addressed by UWB-enabled analytics. With UWB reducing the time spent on these tasks by 10%, this results in annual savings of approximately 16.52 hours. These assumptions are intentionally cautious to reflect realistic adoption rates and operational improvements. Even under these conservative estimates, UWB technology delivers meaningful efficiency gains, allowing analytics teams to act faster on inventory management and marketing strategies. This improvement enhances the overall

[5] In collaboration with Sony and NXP Semiconductors, NTT Docomo developed a payment system that allows consumers to make payments via smartphone based on their location, without having to tap the phone or remove it from a pocket or purse. This system leverages UWB's precise location capabilities to facilitate seamless transactions. Source: https://www.rfidjournal.com/news/mobile-phone-companies-to-demonstrate-uwb-payments/154234/

[6] Unmanned stores can operate 24/7 without staff, eliminating the need for manual tasks such as opening and closing procedures, restocking during off-hours, and handling after-hours customer service. To be conservative in the estimation, we assume an alternative scenario with a store with personnel working 7 hours per Labor Day.

[7] With UWB integrated into smartphones, customers can enter and exit stores without tapping their devices and make secure payments even if their phones remain in pockets or bags. This hands-free approach streamlines access and payment processes, reducing manual labor associated with entry control and checkout. Source: https://www.nxp.jp/company/about-nxp/smarter-world-blog/BL-UNMANNED-STORES

responsiveness of retail operations, making them more dynamic and competitive in adapting to customer needs and market trends.[8]

Exhibition Attendee Management in trade shows and retail expos benefits from UWB by enabling automated attendee tracking and engagement. Traditional methods often involve manual check-ins and badge scanning, which can be time intensive. UWB simplifies these processes, saving approximately 10% of the time required for attendee management tasks. For staff managing events lasting multiple days, this equates to annual savings of around 14 hours[9]. These gains allow event organizers to allocate resources to higher-value activities, such as personalized attendee engagement.[10]

Targeted Marketing benefits significantly from UWB technology, which enables precise, real-time delivery of location-based content and promotions to customers. Traditional marketing methods often require significant time and effort in segmenting audiences and manually tailoring campaigns, leading to inefficiencies. UWB automates these processes, improving accuracy and agility in campaign execution. To estimate potential savings, we assume that marketing teams spend an average of 7 hours daily on campaign development and execution tasks using conventional methods. However, not all campaigns or customer interactions will involve UWB technology. Taking a conservative approach, we estimate that only 5% of the total time spent on marketing activities can currently be attributed to UWB-enabled targeting. With UWB reducing the time spent on these tasks by 10%, this results in annual savings of approximately 8.26 hours. These assumptions are deliberately cautious, reflecting realistic adoption rates and achievable efficiencies. Even under these conservative estimates, UWB technology delivers tangible benefits by allowing marketing teams to focus on more strategic initiatives, driving higher customer engagement and improved sales outcomes.

Drone-Controlled Delivery is a transformative application for logistics in the retail sector. UWB facilitates precise navigation and delivery, reducing errors and the time required for manual handling. Compared to traditional delivery methods, UWB-enabled systems save an estimated 10% of the time per delivery cycle. For a logistics operator managing 500 deliveries annually (assuming 10 minutes per delivery), this equates to an annual savings of

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[8] A study published in the Journal of Ambient Intelligence and Humanized Computing demonstrated the integration of UWB-based localization with image detection techniques to monitor customer shopping paths and traffic in a small-scale supermarket. The system achieved high accuracy in detecting customer movements, enabling retailers to generate frequent path analyses and daily customer traffic reports. This automation reduces manual data processing time and enhances decision-making efficiency. Source: https://link.springer.com/article/10.1007/s12652-020-02236-z

[9] Trade shows and retail expos often span several days. Assuming 20 events annually, each lasting an average of 7 hours daily, staff allocate approximately 140 hours per year to attendee management tasks. A 10% reduction in time spent on these tasks through UWB automation results in 14 hours saved annually.

[10] Minew offers UWB-based personnel tags that enable real-time tracking of attendee movements within exhibition halls. These tags provide exhibitors with data on foot traffic and attendee behavior, enhancing engagement and event management while reducing the need for manual monitoring. Source: https://www.minew.com/personnel-tag/

approximately 8.33 hours[11]. These time savings enable businesses to scale operations more effectively, especially in high-demand markets.

In-Vehicle Payment streamlines tolls and parking transactions by enabling automatic, proximity-based payments. Traditional methods, such as card payments or ticketing systems, often lead to delays, particularly during peak traffic hours. By utilizing UWB technology, transaction times can be reduced by approximately 15%, translating to a daily saving of 27 seconds per user[12] [13] (we assume that in average, each user spends 3 minutes daily on these task). Over the course of a year, this improvement results in an average time savings of 1.77 hours. These efficiencies not only enhance the overall customer experience but also contribute to smoother traffic flow, particularly in high-traffic retail environments.

The conservative estimates in this analysis are further validated by real-world use cases demonstrating the operational efficiency gains enabled by UWB technology. For example, a Qorvo white paper[14] outlines how UWB supports enhanced process flow in retail and logistics environments. In unmanned store access and inventory management scenarios, UWB ensures seamless tracking of goods and customers with centimeter-level accuracy, allowing for more efficient workflows and reduced bottlenecks. Moreover, the technology has proven transformative in logistics, with applications like drone delivery and precise order tracking showing measurable improvements in lead times and accuracy. The ability of UWB to integrate with digital twins and real-time analytics systems has been showcased in various deployments, such as VELUX Modular Skylights and Budweiser Budvar Brewery, where it drove notable productivity gains, including a 10% reduction in work-in-progress and a 19% improvement in warehouse utilization. These examples underline UWB's capability to deliver precise, scalable, and impactful solutions, reinforcing the reliability of the productivity savings estimated in this analysis.

UWB technology delivers measurable productivity gains in the Smart Retail sector, with time savings conservatively estimated between 10% and 15% across key use cases. These improvements translate into significant operational efficiencies, allowing businesses to optimize workflows, reduce delays, and enhance customer satisfaction. By addressing inefficiencies in traditional retail processes, UWB not only drives productivity but also supports a more dynamic and competitive retail landscape (see Table 3-4).

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[11] A typical Amazon Delivery Service Partner (DSP) driver makes approximately 180 stops and delivers 250-300 packages per day. Therefore, estimating that a logistics operator manages 500 deliveries annually is a conservative figure, especially when considering smaller-scale operations or individual logistics providers. Source: https://capitaloneshopping.com/research/amazon-logistics-statistics/

[12] Traditional toll and parking payment methods, such as manual cash transactions or credit card processing, can be time-consuming, especially during peak hours. Studies have shown that drivers spend an average of 17 hours annually searching for parking spaces, indicating significant delays associated with traditional parking systems. Source: https://www.carteeh.org/indicator/time-spent-searching-for-parking/

[13] We assume that less time per user, also implies less time of workers.

[14] Qorvo, White Paper: "UWB Enables Smart Factory of the Future"

Table 3-4. Time savings across key use cases in the Smart Retail Sector

Use Case	Hours Saved Annually	Key Efficiency Gain
Tap-Free Mobile Payment	0.98	Reduces transaction time for faster checkouts
Unmanned Store Access	16.52	Automates customer entry and checkout processes
Foot Traffic and Shopping Behavior Analytics	16.52	Accelerates insights from customer movement data
Exhibition Attendee Management	14.00	Simplifies check-in and engagement tracking
Targeted Marketing	8.26	Reduces time spent tailoring campaigns
Drone-Controlled Delivery	8.26	Improves delivery accuracy and reduces manual handling
In-Vehicle Payment	1.77	Speeds up tolls and parking payments

Sources: Telecom Advisory Services analysis based on Omlox Solutions Use Case example (2024) and Qorvo White Paper: UWB Enables Smart Factory of the Future.

Before finalizing the sample of use cases for the Smart Retail sector, it was necessary to ensure that no overlapping scenarios were included in the analysis. Consequently, only the principal and most distinct use cases—such as tap-free mobile payment, unmanned store access, and drone-controlled delivery—were included in the final analysis. By avoiding similar or derivative scenarios that closely mirror these core categories, the methodology prevents the double-counting of productivity gains and maintains an accurate representation of the sector's net benefits. This approach helps ensure that the measured efficiency improvements are truly incremental and not merely reiterations of already captured functionalities.

Also, use cases such as "Indoor Navigation Finding a Store" or "Time to find a store, etc." lean more toward consumer surplus rather than direct producer gains. They primarily enhance end-user convenience rather than delivering measurable efficiency improvements to the retailer's operations. Including these scenarios in the producer surplus framework might overstate the productivity savings captured, since their main benefits are already accounted for under the consumer surplus dimension.

By keeping a clear distinction between cases that generate operational efficiencies and those that increase user convenience, the methodology avoids double-counting. This separation ensures that benefits attributed to the Smart Retail sector reflect true productivity enhancements from business-driven applications.

3.2.2. Productivity Savings in the industrial sector

The industrial sector provides numerous opportunities for productivity enhancements through UWB technology. By enabling precise location tracking, seamless connectivity, and real-time data access, UWB addresses inefficiencies in traditional processes. This section evaluates five key use cases—indoor navigation, proximity-based patient data sharing, teleconference systems, patient tracking, and industrial real-time location systems (RTLS) and quantifies their associated productivity savings with a conservative estimate of up to 15% in time savings per application.

Indoor Navigation plays a transformative role in large industrial environments such as warehouses, factories, or hospitals. Workers often lose time navigating to find equipment, materials, or specific locations. UWB systems provide real-time guidance, reducing navigation time by approximately 10%. For a worker spending an hour daily navigating[15], this reduction equates to an annual savings of 23.60 hours[16]. These efficiencies are particularly critical in fast-paced environments requiring constant mobility and resource coordination.

Proximity-Based Patient Data Sharing is another critical application, particularly in healthcare settings where time spent retrieving patient records significantly impacts workflows. Traditional systems requiring manual searches are inefficient, but UWB automates this process by linking data to precise locations, saving 10% of the time typically spent on retrieval. For a healthcare worker spending an hour daily on such tasks[17], this translates into approximately 23.60 hours of annual savings. This improved efficiency enables staff to focus their time on direct patient care, enhancing medical service delivery.

Teleconference Systems benefit modestly from UWB, which simplifies meeting setup by automating device connectivity. While traditional teleconference systems often experience delays from manual configurations, UWB reduces setup times by about 5%. For a user participating in regular meetings (1 hours per Labor Day[18]), this results in an annual saving of approximately 11.80 hours. This gain contributes to improved reliability and reduced frustration in industries highly dependent on virtual collaboration.

Patient Tracking offers transformative benefits for managing patient flow in large healthcare facilities. Staff frequently spend time locating patients for treatments, consultations, or emergencies. UWB systems provide real-time updates, reducing search times by approximately 10%. For a professional managing several patients daily (would spend 90 minutes per workday[19]), this equates to 35.40 hours saved annually. This enables

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[15] In industrial environments, workers spend up to 47% of their time locating tools, materials, or equipment, which corresponds to significant daily inefficiencies. Source: https://www.link-labs.com/blog/6-surprising-stats-about-tool-tracking

[16] In all analyses, we standardize the estimation of annual working days to ensure consistency. Starting with the total number of days in a year (365 or 366 for a leap year), we subtract weekends, which account for 104 days (52 weeks × 2 weekend days per week), leaving 261 potential working days. From this, we deduct public holidays, assumed to be 15 days on average, based on variations across countries. This adjustment reduces the total to 246 working days. Lastly, a standard two-week vacation (10 days) is subtracted, resulting in approximately 236 effective working days in a typical year. This framework provides a realistic baseline for calculating productivity gains across all use cases.

[17] A healthcare worker spends approximately 4.5 hours daily working on electronic health records, leaving limited time for patient care and highlighting inefficiencies in record management. Source: https://www.medicaleconomics.com/view/physicians-spend-4-5-hours-a-day-on-electronic-health-records

[18] Professionals report spending 392 hours per year in meetings. Source: https://www.flowtrace.co/collaboration-blog/50-meeting-statistics

[19] Physicians spend only 13% of their time with patients, devoting much of the remaining time to tasks such as locating patients and managing workflow. Source: https://www.amjmed.com/article/S0002-9343(18)30296-1/abstract

healthcare workers to focus on delivering higher-quality care, improving operational efficiency.

Industrial Real-Time Location Systems (RTLS) are a cornerstone of operational efficiency in industrial environments. By automating inventory and asset tracking, UWB RTLS systems save approximately 15% of the time traditionally spent on these tasks. If a worker spends 2 hours daily on these tasks, this translates into 70.80 hours annually[20]. For instance, SEG Automotive, using a UWB-based RTLS, reported significant reductions in human errors and a 50% decrease in lead times, highlighting the transformative potential of this technology.

The conservative estimates in this analysis are further supported by real-world evidence. For example, Omlox-based order tracking systems have demonstrated a 22.5% improvement in productivity, a 27% reduction in error rates, and increased efficiency in logistics workflows. Similarly, Qorvo's study on UWB applications highlights substantial improvements in process flow, asset utilization, and material control, with notable productivity gains in settings like VELUX Modular Skylights and Budweiser Budvar Brewery. These cases exemplify the practical benefits of UWB, reinforcing its role in driving operational efficiency across diverse industrial contexts.

In conclusion, UWB technology delivers measurable productivity gains in industrial applications, with time savings conservatively estimated at 5-15% across key use cases. These improvements translate into significant operational efficiencies, enabling industries to optimize workflows, reduce errors, and allocate resources more effectively. By addressing inefficiencies in traditional processes, UWB not only enhances productivity but also strengthens industrial competitiveness in an increasingly dynamic market (see Table 3-5).

Table 3-5. Time savings across key use cases in the Industrial Sector

Use Case	Hours Saved Annually per User	Key Efficiency Gain
Indoor Navigation	23.60	Reduces time spent locating specific areas or equipment
Proximity-Based Patient Data Sharing	23.60	Automates patient data retrieval for improved workflows
Teleconference Systems	11.80	Simplifies meeting setup and reduces delays
Patient Tracking	35.40	Real-time location updates for efficient patient management
Industrial Real-Time Location Systems	70.80	Automates asset and inventory tracking processes

Sources: Telecom Advisory Services analysis based on Omlox Solutions Use Case example (2024) and Qorvo White Paper: UWB Enables Smart Factory of the Future.

[20] Maintenance technicians often spend a significant portion of their time on non-productive activities, such as locating tools and inventory. Studies indicate that "wrench time"—the actual time technicians spend performing maintenance tasks—averages around 30% to 35% of their workday. This implies that approximately 65% to 70% of their time is consumed by ancillary activities, including searching for tools and parts. For a standard 40-hour workweek, this equates to about 26 to 28 hours spent on non-productive tasks, with a substantial portion dedicated to inventory and asset tracking. Source: https://coastapp.com/blog/wrench-time/

3.3. Assessing Consumer Surplus

Consumer surplus is a critical economic concept used to quantify the societal benefits that arise when a new technology enhances user experiences beyond what is reflected in market prices. In the context of UWB technology adoption, consumer surplus captures the additional value that end-users obtain from UWB-enabled applications—value that exceeds the amount they actually pay. By leveraging UWB's capabilities, such as precise location tracking, reliable connectivity, and effortless automation, consumers benefit from time savings, improved convenience, heightened security, and streamlined daily routines. These advantages manifest themselves across a wide range of scenarios, including smart homes, personal mobility solutions, public transportation systems, and intelligent building environments, underscoring the transformative potential of UWB in everyday life.

Measuring consumer surplus begins by identifying the lifespan and operational cycle of the devices or systems involved in each UWB use case. Assigning realistic lifespans ensures that estimated benefits reflect authentic usage patterns rather than overly optimistic scenarios (See Table 3-6). Next, the methodology determines the number of devices, users, or systems influenced by UWB innovations each year, incorporating not only new adopters but also previously installed units still in operation. By doing so, the analysis captures the evolving penetration of UWB across sectors, developing a dynamic understanding of its widespread impact.

Table 3-6. Estimation of replacement cycles by UWB area

Area	Duration (Years)	Explanation
Point and trigger controller app	2	Consumer electronics evolve quickly; frequent updates ensure compatibility with newer devices and improved UWB precision.
Residential Access control	3	Security-critical systems benefit from regular hardware refreshes to maintain robust encryption and updated proximity protocols.
Easy (logistical) access to personnel devices	2	Rapid turnover of personal electronics (phones, wearables) dictates frequent renewal to maintain seamless integration and connectivity.
All Gaming	2	Gaming peripherals and consoles update often; short cycles ensure best performance and compatibility with evolving UWB-enabled features.
Audio streaming	2	Audio standards and codecs change regularly; frequent hardware updates ensure quality streaming and interoperability with new sound systems.
Gesture-based control	2	Gesture recognition technology improves rapidly; short cycles guarantee accurate sensing and responsiveness.
VR Gaming and group play	2	VR hardware changes rapidly for better tracking and reduced latency; frequent updates maintain cutting-edge immersion.
Find someone/something nearby	2	Precise tracking solutions require timely hardware upgrades to ensure accuracy and adaptability to new device ecosystems.
Smart speaker shipment	2	Smart speaker platforms evolve quickly, requiring updated chips for enhanced voice recognition and UWB integration.
Presence based device activation	2	Presence detection relies on advancing UWB tech; short cycles ensure accurate and energy-efficient activation.
Parking garage access control	3	Infrastructure devices face moderate wear; updates every 3 years maintain security standards and compatibility with changing vehicle UWB protocols.
Indoor navigation	3	Location-based services in complex environments need periodic hardware upgrades to remain precise amidst evolving mapping standards.
Vehicle digital key (car access)	2	Keys and related tech update frequently to stay secure and compatible with new vehicle models and security protocols.
Rider identification in private transport services	2	Rapid turnover in personal devices (e.g., smartphones) requires frequent updates to ensure accurate and secure rider identification.

Area	Duration (Years)	Explanation
eID validation in crowded environments	2	Security and identification standards evolve quickly, necessitating regular hardware renewals for reliability and fraud prevention.
V2X and autonomous driving	3	Automotive systems update steadily with industry standards; 3-year cycles ensure alignment with safety and communications protocols.
Driverless valet parking and pickup	3	Autonomous parking systems require consistent hardware refreshes to maintain system accuracy, safety certifications, and integration with new vehicles.
EV Charging	3	Charging infrastructure evolves with new standards (e.g., faster charging, updated UWB communication), warranting periodic device replacements.
Toll collection	3	Electronic tolling is stable but requires periodic upgrades to ensure continued interoperability, payment security, and UWB accuracy.
Open trunk with gesture	3	User interfaces for vehicles update rapidly for responsiveness and security; short cycles ensure optimal performance.
In cabin sensing	3	Cabin sensors must keep pace with changing safety and comfort standards; a 3-year renewal maintains up-to-date sensing capabilities.
Smart watches	2	Consumer wearables follow a fast innovation cycle; frequent updates align with new features, enhanced battery life, and better UWB integration.
UWB Smartphones	2	Smartphones are replaced every 2-3 years on average; a 2-year cycle is conservative and ensures compatibility with the latest UWB standards.
Ticket validation in public transport services	3	Infrastructure devices face less wear than consumer gadgets but must update regularly to maintain security and interoperability with evolving standards.
Reserved seat validation	3	Periodic hardware refreshes ensure accurate seat detection and authentication as passenger volumes and ticketing systems evolve.
Ride sharing (precise positioning)	2	Consumer-facing services depend on smartphone cycles; frequent upgrades ensure accurate, secure tracking and quick adoption of new UWB features.
Transportation sharing (find a bike or scooter nearby)	2	Shared mobility devices and docking stations evolve rapidly; frequent renewal ensures accurate positioning and secure rentals.
Transportation fare payment	3	Payment systems update moderately; a 3-year cycle allows secure, standardized upgrades while keeping pace with fintech changes.
Physical Access control	3	Building-level security systems need regular updates to remain aligned with current encryption and safety standards.
Controlled access	3	Access systems face moderate usage and security threats; a 3-year replacement ensures up-to-date authentication technologies.
Employee gathering in emergencies	3	Emergency systems must remain reliable and interoperable; renewing every 3 years ensures compatibility with evolving safety regulations and protocols.

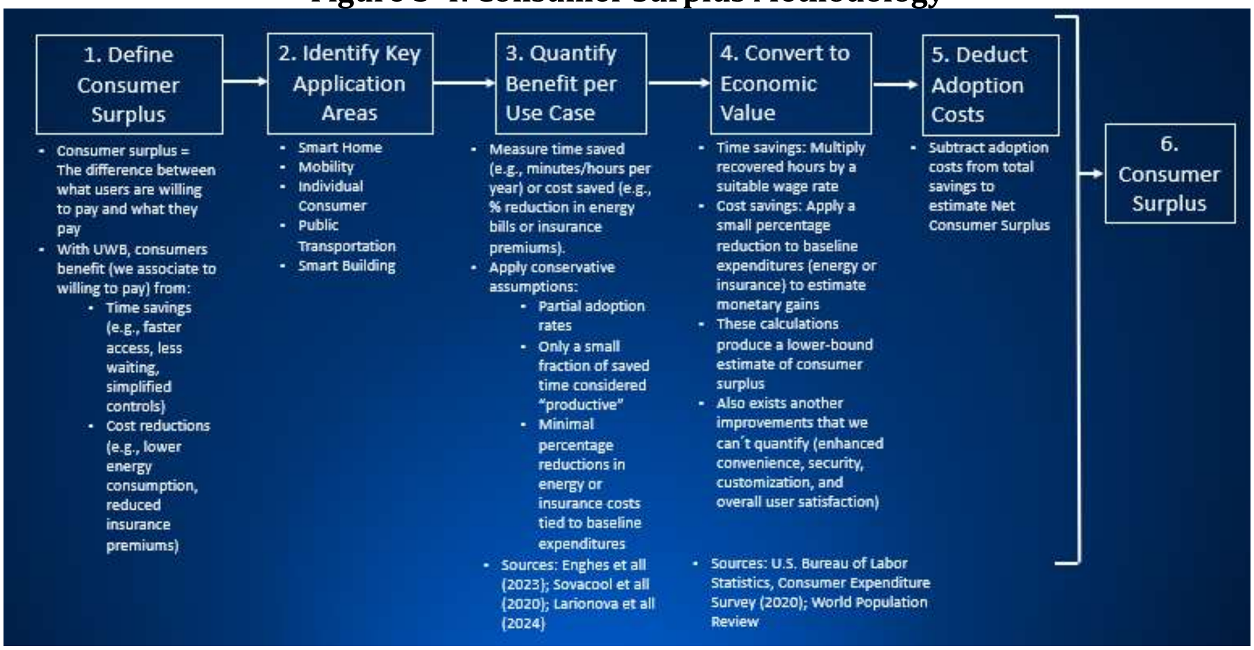
Source: Telecom Advisory Services analysis

Quantifying consumer surplus then requires translating non-monetary benefits into measurable metrics. Many UWB advantages—reduced frustration, faster navigation, energy savings, or more efficient device management—translate into concrete time savings and cost reductions. For example, if UWB-enabled automation frees several minutes per day otherwise spent on manual tasks, these accrued minutes can be aggregated into annual hours. Similarly, if presence-based device activation lowers energy consumption, the resulting financial savings can be quantified. These non-monetary gains are then converted into economic terms by applying conservative proxies, such as a fraction of the minimum wage rates or average salaries, to represent the opportunity cost of saved time or the financial value of reduced expenditures.

Because not all users fully leverage UWB capabilities and not all reclaimed time is used productively, the methodology incorporates adoption rates and productivity fractions. Adoption rates estimate the proportion of end-users who actively utilize UWB features, while productivity fractions[21] assume that only a modest percentage of freed time yields tangible economic gains. By systematically applying these conservative assumptions, the final estimates tend toward caution, producing a reliable lower bound for consumer surplus. This prudent approach prevents inflated valuations and aligns the analysis with realistic patterns of user behavior.

In sum, this methodology constructs a rigorous, data-driven framework for capturing UWB's value to consumers (See Figure 3-4).

Figure 3-4. Consumer Surplus Methodology



Source: Telecom Advisory Services

By linking device lifespans, adoption figures, quantified time savings, and energy reductions to transparent economic assumptions, it reveals how UWB-enabled technologies generate

[21] The estimation of productivity gains relies on the assumption that only a fraction of the freed time, resulting from UWB-enabled efficiencies, is utilized for productive activities. In most regions, this proportion is conservatively set at 5%. Such a stringent assumption aims to mitigate the risk of overstating economic benefits by acknowledging that not all saved time will be spent on revenue-generating or otherwise economically valuable tasks. In essence, this conservative parameter ensures the resulting estimates on the side of caution rather than optimism. In the specific context of Nigeria and other African countries, the chosen proportion of productively utilized time will be adjusted upward to 10%. This modification accounts for lower baseline wage levels, where even marginal improvements in time allocation have the potential to yield relatively greater benefits. By increasing the assumed productive use of freed time, the analysis more accurately reflects the heightened sensitivity of labor markets in lower-income settings to incremental efficiency gains and enhanced workforce availability. While it might be argued that the entirety of the newly available time could be dedicated to productive pursuits, such a scenario would be optimistic. Societal and individual factors inevitably limit the proportion of freed time that can be devoted to additional work or skill development. Hence, the adoption of a conservative approach—5% in general and 10% in select lower-wage regions—strikes a balance between acknowledging the economic potential of time savings and recognizing the practical constraints of the labor market dynamics.

genuine societal benefits. Before examining the individual use cases in detail, it is essential to recognize that the resulting estimates, though conservative, highlight UWB's capacity to deliver everyday improvements that transcend traditional market metrics and enrich the broader socio-economic landscape.

3.3.1. Consumer Surplus in Smart Home use cases

Smart home applications enabled by UWB technology bring significant value to consumers through enhanced convenience, energy efficiency, security, and customization. These applications streamline daily tasks, reduce costs, and improve the overall user experience. This section evaluates the consumer surplus associated with specific use cases in smart home settings, focusing on quantifiable benefits across these dimensions.

The **Point and Trigger Control App** enables users to manage multiple smart home devices through a single, intuitive gesture that leverages UWB's precise spatial awareness. Rather than navigating separate applications, issuing voice commands, or scrolling through menus, the user can simply point their smartphone or a dedicated controller toward the desired device to trigger an action. This direct interaction reduces the cognitive burden and incremental time losses associated with conventional control methods, ultimately streamlining daily routines in the home environment.

To estimate the quantifiable benefits, we assume that a typical user currently allocates approximately two minutes per day to managing various devices. By nearly eliminating this time expenditure, the Point and Trigger Control App can generate a potential annual saving of roughly 12.17 hours per fully engaged user (2 minutes/day × 365 days ≈ 730 minutes or 12.17 hours/year)[22]. Recognizing that not all users will fully adopt or consistently utilize this functionality, we apply a conservative 5% utilization rate[23] among those who have access to the app. Under this assumption, the average annual time savings across the entire user base decreases to about 0.61 hours per user. Further caution is introduced by assuming that only 5%/10% of these reclaimed hours would translate into productive activities. Although these parameters are conservative and illustrative rather than definitive, they provide a tangible baseline for understanding the economic value of convenience gains.

It is important to acknowledge that the aforementioned calculation does not capture additional sources of consumer surplus enabled by this technology. For instance, intangible

[22] According to other analyses, automated routines can save approximately 3.5 hours per week (182 hours per year), centralized control about 2 hours per week (104 hours per year), remote access about 1 hour per week (52 hours per year), predictive analytics about 2 hours per week (104 hours per year). The conservative figure of two minutes per day used in our estimation pales in comparison to these documented gains, thereby ensuring we do not overstate the benefits. This approach not only adds rigor to our analysis but also underscores that the actual value delivered by UWB-enabled functionalities is likely much greater than our baseline assumption suggests. Source: https://bettersmarterhome.com/blog/investment/how-a-smart-home-can-save-you-time/

[23] Our decision to keep the 5% utilization rate unchanged reflects a cautious modeling choice. In reality, usage likely grows as consumers become more accustomed to UWB's functionalities, which would potentially enhance the overall benefits.

benefits such as reduced frustration, more seamless integration of new devices, decreased reliance on technical support, and improved accessibility for users with mobility or dexterity challenges remain unquantified. Similarly, the mental relief of avoiding complex navigation and the enhanced harmony that arises from multiple household members easily controlling shared devices also contribute to the overall value. While difficult to express in monetary terms, these qualitative improvements further underscore the transformative potential of UWB technology for enriching everyday home life.

Residential Access Control systems enabled by UWB technology allow homeowners to manage entry points with dynamic, proximity-based digital keys. Rather than relying on traditional physical keys, users benefit from encrypted communication and precise location data to authenticate and authorize access. This approach streamlines the process of entering and exiting the home, deters unauthorized entry, and provides real-time oversight of occupancy. As a result, homeowners experience enhanced security and increased peace of mind regarding who enters their living spaces.

To estimate the quantifiable benefits, we focus on potential savings in property insurance costs. As a conservative starting point, we assume that households allocate approximately 1% of their annual income to insurance premiums[24], where annual income is derived from the hourly minimum wage extended over a year. Under this assumption, a UWB-enabled Residential Access Control system in a high-income country could reduce insurance expenses by roughly 5%, reflecting the enhanced security baseline. In lower-income regions, where insurance markets and security standards may differ, a 10% reduction is posited to acknowledge potentially greater relative impacts[25]. By correlating security improvements with decreased insurance costs—and adjusting these estimates according to regional wage levels and market conditions—this methodology provides a flexible and scalable framework for quantifying consumer surplus.

While these figures capture a key financial dimension, other valuable benefits remain unquantified. For instance, the added convenience of remotely locking and unlocking doors, the decreased need to replace or manage physical keys, the potential for integrating temporary digital passes for guests or service providers, and the reduced stress associated with maintaining home security protocols all contribute to consumer welfare. Although challenging to measure in strictly monetary terms, these intangible advantages further underscore the transformative potential of UWB-enabled Residential Access Control to enhance everyday life.

Easy (Logical) Access to Personal Devices leverages UWB technology to automate proximity-based connections between users' personal devices—such as smartphones,

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[24] In 2020, U.S. households spent an average of 1.93% of their income on homeowners' insurance premiums. Source: https://www.insurance-research.org/sites/default/files/news_releases/Homeowners%20Affordability%20Brief.pdf

[25] Insurers assess the level of risk associated with insuring a property and determine premiums accordingly. The presence of advanced security systems significantly mitigates the risk of theft, vandalism, and other threats, reducing the likelihood of claims. Source: https://resolutepartners.com/securing-your-property-a-pathway-to-lower-insurance-premiums/

tablets, and laptops—and their home systems. Instead of manually pairing devices or navigating multiple settings menus, the environment seamlessly recognizes and adapts to individual preferences as users move from one device to another. This functionality not only simplifies day-to-day management of personal electronics but also helps create a more cohesive and user-centric digital ecosystem.

To quantify the potential benefits, we begin with an estimate that seamless integration saves roughly 15 minutes per week, or about 780 minutes (13 hours) per year, per user.[26] Applying the conservative scaling practices used previously, we assume that only a small fraction of these reclaimed hours (5%/10%) would be dedicated to productive activities. Multiplying this fraction by a suitable hourly wage provides an illustrative measure of the economic value associated with enhanced convenience and customization. This conservative approach ensures that the resulting figures remain grounded in realistic scenarios, even as actual benefits may prove more substantial.

It is important to note that this calculation does not capture other, less tangible improvements. For example, reduced user frustration, more fluid transitions between devices, decreased need for technical assistance, and the potential for better accessibility all remain unquantified. These qualitative advantages further highlight the transformative potential of UWB-enabled device integration, enhancing the overall quality and satisfaction of the user's digital experience.

The **All-Gaming** use case leverages UWB technology to streamline the process of engaging with various gaming devices and platforms. Rather than manually adjusting inputs, synchronizing controllers, or configuring multiple consoles and accessories, users benefit from a setup where devices recognize each other seamlessly and activate optimally. This reduces the time and effort required to start playing, whether transitioning between a traditional console, or a gaming PC.

To gauge the quantifiable benefits, consider a user who currently dedicates about 10 minutes per day[27] to device adjustments and configurations before starting a gaming session. Over an entire year, this routine expenditure amounts to roughly 60.8 hours of saved time if effectively minimized by UWB integration. Applying the same conservative methodologies as before, assume that only 5% of users who have access to this functionality fully utilize it. Under this assumption, the average annual time savings per user (across all users) decreases to about 3.04 hours. Further conservatism is introduced by positing that only 5%/10% of these recovered hours yield economically productive activities. Although such assumptions

[26] According to another analyses, integrative platforms can save about 1.5 hours per week (78 hours per year). The conservative figure of 15 minutes per week used in our estimation pales in comparison to these documented gains, thereby ensuring we do not overstate the benefits. Source: https://bettersmarterhome.com/blog/investment/how-a-smart-home-can-save-you-time/

[27] U.S. teens aged 15 to 19 years spent an average of 98.4 minutes per day on gaming and leisure computer use in 2023. While these figures pertain to gameplay duration rather than setup time, they provide insight into the daily time investment associated with gaming activities. Source: https://www.statista.com/statistics/502149/average-daily-time-playing-games-and-using-computer-us-by-age/

are intentionally strict and do not capture variations in personal behavior, they offer a pragmatic lower-bound estimate for the economic value of the convenience and personalization afforded by UWB-based gaming integration.

It is essential to acknowledge that these calculations do not consider other valuable but less easily quantifiable benefits. For instance, reduced frustration, smoother transitions between gaming environments, decreased reliance on troubleshooting, and an enhanced capacity to tailor gaming experiences all contribute to improved user satisfaction. Such intangible gains further reinforce the transformative potential of UWB technology to enrich the quality and enjoyment of gaming in everyday life[28].

UWB-enabled audio streaming transforms the way users interact with their home audio systems by automating device recognition and playback management. Rather than manually switching speakers, adjusting volume, or navigating multiple applications, this solution ensures that music seamlessly "follows" the user from room to room. When an individual enters a new space, the system automatically detects their presence and instantly shifts audio output to the nearest UWB-enabled speaker, thereby reducing the effort and interruptions commonly associated with traditional audio setups.

To estimate the quantifiable benefits, consider a user who currently dedicates about 2 minutes per day to managing audio devices—switching rooms, pairing headphones, or reconfiguring streaming settings.[29] Over the course of one year, these incremental daily tasks accumulate to approximately 730 minutes, or about 12.17 hours of saved time for a fully engaged user. Applying the conservative assumptions used in prior analyses, assume that only 5%/10% of these freed hours contribute to productive activities. Multiplying this fraction by a suitable hourly wage provides a lower-bound estimate of the economic value arising from the convenience gains associated with UWB-enabled audio streaming.

It is important to recognize that these calculations do not account for other dimensions of consumer surplus. Improvements in user satisfaction from effortless device coordination, reductions in frustration due to fewer technical adjustments, and greater accessibility for individuals who may find conventional interfaces challenging are not monetized here. Moreover, intangible benefits—such as enhanced enjoyment, improved ambience, and the capacity for multiple household members to share a cohesive audio environment—extend beyond the quantifiable metrics. While not directly measured, these qualitative enhancements underscore the broader transformative potential of UWB-based audio streaming to enrich everyday home life.

[28] Also, UWB offers better latency than other technologies. Source: https://www.sparkmicro.com/for-hardcore-gamers-every-millisecond-matters-why-uwb-beats-bluetooth-every-time/

[29] Considering the substantial daily engagement with audio content—averaging over an hour and a half per day in the United States —it is reasonable to estimate that users might spend approximately two minutes each day managing audio devices. This time encompasses tasks such as switching rooms, pairing headphones, or adjusting streaming settings. While individual experiences may vary, this estimate provides a plausible basis for assessing potential time savings through UWB-enabled automation. Source: https://www.statista.com/statistics/1229590/digital-audio-consumption-united-states/

Gesture-based control leverages UWB technology to enable users to operate their smart home devices through simple hand movements. This approach removes the need for physical interfaces—such as buttons, remotes, or smartphone unlock sequences—and simplifies the user experience. Instead of searching for controllers or navigating screens, residents can adjust lighting, temperature, media playback, and other settings using intuitive, motion-based commands.

The key advantages of this use case lie in enhanced convenience and improved accessibility. In terms of convenience, reducing manual interactions can substantially cut down on daily effort. For instance, consider a scenario where each interaction previously required approximately three minutes.[30] Over the course of a year, these incremental savings could sum to around 18.25 hours for a fully engaged user. Furthermore, gesture-based controls can significantly improve accessibility, particularly for individuals with mobility challenges, by minimizing physical barriers and making device management more inclusive.

To estimate the economic value of these gains, we continue with the conservative assumptions employed in previous analyses. Suppose that only 5% of the saved hours are devoted to productive activities and then apply an appropriate hourly wage. Although such an approach is deliberately cautious and does not account for the various ways users might allocate their freed time, it yields a tangible, scalable reference point for understanding the consumer surplus generated by UWB-enabled gesture-based control. At the same time, it is worth noting that additional, qualitative benefits—such as reduced frustration, easier device navigation, and an overall enhanced user experience—remain unquantified, further underscoring the transformative potential of this technology.

UWB technology enhances **virtual reality (VR) gaming** by providing highly accurate tracking and effortless connectivity for multi-user setups. Rather than spending time configuring sensors, adjusting camera angles, or syncing multiple controllers, users benefit from an environment where VR devices recognize each other seamlessly and automatically optimize their settings for group play. This substantially reduces the complexity and time required to initiate gaming sessions, enabling players to start more quickly and enjoy a fully immersive experience.[31]

From a quantifiable perspective, the primary advantage lies in substantial time savings. Consider a user who previously spent 10 minutes configuring their VR system before each session. By halving this preparation time to 5 minutes, and assuming about four sessions per week, the annual savings add up as follows:

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[30] According to another analyses, centralized control can save about 2 hours per week (104 hours per year). The conservative figure of used in our estimation pales in comparison to these documented gains, thereby ensuring we do not overstate the benefits. Source: https://bettersmarterhome.com/blog/investment/how-a-smart-home-can-save-you-time/

[31] Unlike the “All Gaming” scenario, which focuses broadly on streamlining interactions across various gaming platforms and devices, VR gaming improvements primarily target specialized equipment and multi-user configurations. The result is a more focused enhancement in user experience, tailored specifically to the demands of immersive virtual environments.

- 5 minutes saved per session × 4 sessions per week = 20 minutes saved per week
- 20 minutes per week × 52 weeks ≈ 1,040 minutes per year, or approximately 17.3 hours

This conservative estimate indicates that a frequent VR gamer could reclaim about 17.3 hours annually. Applying the same cautious approach as in previous analyses, assume that only a small portion (5% in higher-income settings and 10% in lower-income contexts) of these recovered hours translate into productive activities. Multiplying this fraction by a suitable hourly wage offers a baseline for the economic value derived from UWB-enabled VR gaming improvements.

It is important to note that these calculations do not encompass all the qualitative benefits. Beyond time savings, customization enables players to tailor connectivity and performance to their specific preferences, providing a more dynamic and immersive gaming environment. Reduced frustration, smoother group interactions, and an enhanced capacity to integrate emerging technologies all contribute to a richer VR experience. Although more challenging to quantify, these intangible improvements further underscore the transformative potential of UWB technology within the realm of virtual reality gaming.

UWB's high-precision tracking capabilities enable users to locate misplaced items or individuals within their home environment quickly and efficiently (**Find Someone/Something Nearby)**. Instead of spending time searching for keys, wallets, remote controls, or other essentials, homeowners can rely on UWB-enabled devices to pinpoint the exact location of these objects. Additionally, this feature enhances household safety by allowing family members to locate children or elderly relatives within the home in real-time, offering greater peace of mind.

To approximate the potential time savings, consider a scenario in which a user spends about 10 minutes searching for misplaced items twice a week, totaling 20 minutes per week. Over the course of a year, this amounts to approximately 1,040 minutes, or about 17.3 hours of reclaimed time[32]. Applying the same conservative assumptions as in previous calculations, assume that only a small fraction (5% in higher-income regions and 10% in lower-income contexts) of these recovered hours is devoted to economically productive activities. Multiplying this fraction by a suitable hourly wage provides a baseline estimate of the consumer surplus associated with UWB-enabled item tracking.

While these figures remain conservative and illustrative, they only represent one aspect of the value derived from UWB-enabled item tracking. In reality, much of the technology's impact extends beyond what can be captured in numerical terms. For instance, the reduction

[32] Studies indicate that the average person spends approximately 2.5 days annually—equating to about 60 hours—looking for lost belongings such as keys, wallets, and remote controls. Source: https://www.prnewswire.com/news-releases/lost-and-found-the-average-american-spends-25-days-each-year-looking-for-lost-items-collectively-costing-us-households-27-billion-annually-in-replacement-costs-300449305.html

in daily stress from not having to search for essentials, the sense of comfort and security in knowing where family members are at any given moment, and the smoother household interactions that arise when conflicts over misplaced items are minimized all contribute to a higher quality of life. These intangible improvements—ranging from enhanced peace of mind to stronger household cohesion—underscore the profound, yet less easily quantifiable, benefits that UWB technology can deliver to everyday home environments.

A UWB-enabled **smart speaker** advances beyond traditional audio streaming by incorporating precise location tracking and device recognition to deliver a more integrated, context-aware experience. Instead of merely ensuring that music follows the user throughout the home, this technology adapts playback and other settings automatically based on user presence and behavior. For example, as a user enters a room, the system could adjust volume levels, switch from background music to a requested podcast, or even coordinate with other connected devices—such as altering lighting or providing schedule reminders—to create a tailored and responsive environment.

From a quantifiable standpoint, the primary benefit lies in significant time savings. Consider a scenario in which a user currently spends about three minutes per day reconfiguring speakers, changing playlists, or adjusting voice assistant commands in different rooms.[33] By minimizing these repetitive tasks, the UWB-enabled smart speaker could reduce this daily effort to nearly zero, amounting to roughly 1,095 minutes per year, or approximately 18.25 hours saved for a fully engaged user.

Applying the conservative methodology used in previous analyses, assume that only a small fraction (e.g., 5%/10%) of these reclaimed hours are devoted to productive activities and then assign an hourly wage to approximate their economic value. Although these figures are illustrative and cannot account for the diverse ways users might allocate their free time, they offer a practical, scalable framework for gauging the consumer surplus generated by UWB-enabled smart speakers. Beyond the direct time savings, intangible benefits—such as reduced frustration, greater accessibility, and a more harmonious integration of home technologies—further underscore the transformative potential of this approach compared to conventional audio streaming solutions.

Presence-based device activation leverages UWB technology to automatically power devices on or off depending on whether a room is occupied. This approach goes beyond simple convenience: it directly influences energy consumption patterns within the home. By ensuring that lights, climate controls, and other appliances are active only when someone is present, the system reduces unnecessary energy use, leading to tangible savings on household energy bills.

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[33] Considering that the average U.S. adult spends approximately 1 hour and 43 minutes per day listening to digital audio content, it's conservative that users dedicate 3 minutes each day to configuring their audio settings to suit different environments or preferences. Source: https://www.emarketer.com/content/us-adults-spend-fifth-daily-digital-media-time-digital-audio

Unlike previous use cases that focused on time savings, this scenario primarily yields benefits through cost reductions stemming from improved energy efficiency. Sovacool and Del Rio (2020) emphasize that energy expenditures are a significant component of household budgets, particularly in developed regions, where smart technologies such as automated lighting and climate control systems offer meaningful savings. These systems are designed to operate with greater efficiency, reducing the waste associated with traditional manual controls. Moreover, integrating these technologies aligns with broader sustainability goals, as households become more responsive to energy demand and usage patterns. To frame these savings, assume that a household spends approximately 1% of its annual income on energy costs. This figure is derived conservatively from a baseline income estimate (for instance, annualizing the hourly minimum wage), ensuring it remains on the lower side and thus not overstating potential benefits.[34]

With presence-based activation, devices consume less power in unoccupied rooms. While initial estimates suggest potential reductions of 8–15%, to maintain a conservative approach, we will assume that this system lowers energy consumption by just 5%.[35] [36]Even at this reduced rate, households can realize meaningful savings on their annual energy bills. The exact amount depends on local electricity rates, household habits, and the baseline efficiency of devices, but this conservative assumption ensures that our estimates do not overstate the economic benefits. By linking energy expenses to a fraction of household income and applying a modest percentage-based reduction, we establish a transparent and flexible methodology to estimate consumer surplus arising from energy efficiency gains.

In addition to energy savings, customization adds another layer of value. Presence-based systems can recall user preferences—such as desired lighting intensities or climate conditions—and apply them the moment a user enters the room, enhancing comfort without additional manual input. Although this contribution to customization is less easily

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[34] Presence-based device activation utilizing UWB technology can significantly enhance energy efficiency by ensuring that appliances operate only when needed. This approach is particularly impactful given that, on average, U.S. households allocate approximately 2.7% of their annual income to home energy expenditures. By automating the activation and deactivation of devices based on room occupancy, UWB technology can reduce unnecessary energy consumption, leading to tangible savings on household energy bills. Implementing such smart energy management systems not only contributes to cost savings but also promotes sustainable energy use within the home. Source: https://www.eia.gov/todayinenergy/detail.php?id=10891&

[35] Larionova et al. (2024) further elaborate on the economic impact of smart home devices, highlighting that smart thermostats and lighting systems can achieve energy savings of up to 15%, averaging 8.5% (75 kWh per month, and assuming an average consumption of 877 kWh per month). These technologies optimize usage by adapting to real-time conditions and occupant behavior, providing not only financial benefits but also increased convenience and comfort. When applied to UWB-enabled systems, the ability to automate energy consumption based on room occupancy can compound these benefits, reducing household energy use without requiring active management by users.

[36] Engheș et al. (2023) highlight the significant economic benefits associated with smart homes, particularly in terms of energy savings and operational efficiency. By incorporating technologies such as smart thermostats, LED lighting, and controlled ventilation systems, smart homes can optimize energy use and reduce electricity consumption by up to 15%. This not only leads to lower energy bills but also offers a quick return on investment through enhanced energy management. Additionally, the ability to automate tasks, such as adjusting temperature settings based on room occupancy, contributes to further cost reductions and increases the overall financial viability of implementing smart home systems

quantifiable in monetary terms, it further supports the conclusion that UWB-enabled presence-based device activation delivers meaningful consumer surplus through both reduced costs and improved everyday living conditions.

Additionally, Sovacool and Del Rio (2020) note that the adoption of smart systems enhances energy efficiency and contributes to long-term environmental goals. The ability to track and adjust energy usage in real-time creates a feedback loop that encourages responsible consumption. For instance, by automating the activation of devices only when rooms are occupied, households can further reduce their carbon footprint. These arguments collectively demonstrate that the integration of UWB-enabled presence-based activation systems can significantly contribute to both economic and environmental outcomes, providing a practical pathway for improving energy efficiency in modern homes.

In conclusion, smart home use cases powered by UWB technology deliver substantial consumer benefits, enhancing convenience, security, energy efficiency, and customization. These features translate into measurable time savings, cost reductions, and improved user experiences. By quantifying these benefits across specific applications, this section underscores the transformative impact of UWB technology in the smart home sector, providing a foundation for broader socio-economic analyses (See Table 3-7).

Table 3-7. Consumer Surplus in Smart Home Use Cases

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Point and Trigger Control App	Time	~12.17 hours/user/year	~0.61 hours/user/year (after 5% adoption/use) → ~0.030 hours/user/year (5% productivity of that time)
Residential Access Control	Cost (Insurance)	~5-10% reduction in property insurance costs (assumes 1% of income on insurance costs)	Same percentages (5% high-income regions, 10% lower-income), no further scaling applied
Easy (Logistical) Access to Personal Devices	Time	~13 hours/user/year	~13 hours/user/year → ~0.65 hours/user/year (5% productivity of that time)
All Gaming	Time	~60.83 hours/user/year	~3.04 hours/user/year (5% adoption) → ~0.152 hours/user/year (5% productivity of that time)
Audio Streaming	Time	~12.17 hours/user/year	~0.61 hours/user/year (5% productivity)
Gesture-Based Control	Time	~18.25 hours/user/year	~0.91 hours/user/year (5% productivity)
VR Gaming and Group Play	Time	~17.3 hours/user/year	~0.865 hours/user/year (5% productivity)
Find Someone/Something Nearby	Time	~17.3 hours/user/year	~0.865 hours/user/year (5% productivity)
Smart Speaker	Time	~18.25 hours/user/year	~0.91 hours/user/year (5% productivity)

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Presence-Based Device Activation	Cost (Energy)	~5% reduction in energy costs (assumes 1% of income on energy)	Same percentage (5% of that 1% income), no further scaling applied

Source: Telecom Advisory Services analysis

3.3.2. Consumer Surplus in Mobility use cases

Mobility applications occupy a central role in modern life, influencing how individuals commute, travel for leisure, and access a variety of transportation services. As the automotive industry evolves toward more connected, autonomous, and shared models of mobility, UWB technology presents an opportunity to improve many aspects of the travel experience. By delivering precise location awareness, seamless device pairing, and secure communications, UWB can streamline operations like parking garage access, digital key management, and navigation services, ultimately enhancing convenience, reducing wait times, and increasing passenger confidence.

From the perspective of consumer surplus, these advancements translate into measurable benefits for end-users. Enhanced accuracy and reliability in vehicle access, guidance, and payment systems can save travelers time, decrease stress, and minimize the frustration associated with traditional processes. For instance, UWB technology can eliminate the need to search for tickets or adjust multiple settings manually, allowing users to focus on more meaningful activities during their journeys. Over time, these improvements accumulate, yielding appreciable gains in efficiency and user satisfaction.

As with other areas of UWB application, the full extent of consumer surplus in mobility contexts depends on a range of factors, including user adoption rates, regional infrastructure standards, and variations in driving or commuting habits. Nevertheless, by applying conservative assumptions and focusing on quantifiable outcomes, it is possible to establish robust lower-bound estimates of the value UWB offers to individual travelers. In doing so, this analysis underscores the potential for UWB integration to make mobility more user-centric, convenient, and economically beneficial for a diverse range of consumers.[37]

UWB integration in **parking garage access control** systems can significantly streamline the process of entering and exiting facilities. Instead of relying on physical tickets, key cards, QR codes, or smartphone apps—all of which may require manual interaction and can cause delays, especially during peak hours—UWB-enabled gates recognize authorized vehicles automatically as they approach. This hands-free authentication raises the barrier without additional steps, reducing queues and alleviating driver frustration.

[37] Consumer surplus in mobility could also be reflected in the additional price consumers are willing to pay for vehicles equipped with UWB technology. Current evidence indicates that consumers are indeed paying a premium for such vehicles, as UWB enables advanced features like precise localization, seamless keyless entry, and enhanced safety systems. However, the available data is limited, and a broader sample is required to accurately quantify the price gap between vehicles with and without this technology.

From a consumer surplus standpoint, the principal advantage is time savings. Consider a scenario in which a driver currently spends about 60 seconds each time he or she enters or exits a parking garage[38]. Visiting such facilities five times per week accumulates to roughly five minutes per week, or approximately 260 minutes per year. By employing UWB-based access control, much of this time could be reclaimed. Applying a conservative assumption that only 5% to 10% of these recovered minutes translate into productive activities or financial gains, the resulting estimate provides a tangible, lower-bound measure of the consumer surplus achieved.

It is essential to recognize that these calculations do not capture all the qualitative benefits. Beyond the direct time savings, UWB-enhanced systems reduce driver stress, minimize congestion at entry points, and foster a more user-friendly parking environment. These intangible improvements—ranging from enhanced convenience to improved traffic flow—further underscore the transformative potential of UWB technology in everyday mobility scenarios.

UWB-enhanced **indoor navigation** systems deliver precise, real-time guidance in complex mobility environments, including multi-level parking garages, large transportation hubs, and expansive vehicle storage facilities. These benefits also apply to enclosed parking garages at large shopping centers, where UWB guidance helps drivers find spaces more quickly and reduce congestion in busy retail environments. Instead of relying on unclear signage or resorting to trial-and-error, drivers benefit from accurate directions that streamline their search for available spaces, exit ramps, or specific destinations. By reducing uncertainty, UWB-based navigation minimizes confusion, shortens dwelling times, and alleviates congestion within enclosed areas. By doing this on the user's device it enables this while allowing for full privacy protection of the user.

To illustrate the potential time savings, consider a driver who currently spends about 20 seconds twice per week searching for a parking spot or navigating out of a complex structure.[39] Over the course of a year (52 weeks), these delays accumulate to approximately 34.67 minutes, or roughly 0.58 hours. With UWB-based navigation, much of this time can be reclaimed. Following the conservative methodology applied in previous analyses, we assume that only 5% to 10% of these recovered minutes translate into productive activities. Even under such stringent assumptions, the estimated gains provide a tangible lower bound for the consumer surplus that results from more efficient indoor guidance.

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[38] While the barrier itself may take approximately 4 to 6 seconds to open or close, the overall time for a driver to enter or exit a parking garage is significantly longer when considering additional tasks such as ticket retrieval, payment processing, and potential delays from vehicle queues. These combined activities can extend the total time to around 60 seconds per entry or exit. Source: https://parklio.com/en/blog/how-to-optimize-parking-flow-in-underground-garages-proven-strategies-and-real-world-examples

[39] Shoup (2006) indicates that drivers typically spend between 3.5 to 14 minutes searching for parking in urban settings. While this timing is more pronounced in densely populated areas, it is reasonable to estimate that in less congested environments, such as multi-level parking garages or large transportation hubs, a driver might spend approximately 20 seconds per search. Implementing UWB-enhanced indoor navigation systems can significantly reduce this time by providing precise, real-time guidance, thereby improving overall efficiency and user experience. Shoup, D.C (2006). "Cruising for parking". *Transportation Policy* 13(6), 479–486

It is important to acknowledge that these calculations do not encompass the full spectrum of advantages afforded by UWB integration. Reduced stress, more predictable traffic flows within enclosed environments, and an overall improvement in driver satisfaction are all intangible benefits that further enhance the value proposition. Taking together, these qualitative improvements underscore how UWB-enabled indoor navigation can fundamentally elevate the user experience in everyday mobility scenarios.

UWB-enabled digital keys provide a secure, intuitive, and hassle-free method for drivers to access their vehicles. Traditional reliance on physical keys or fobs can lead to inconvenience, as these items may be misplaced or require manual interaction. While existing keyless entry systems address some of these issues, they often depend on less precise radio-frequency technologies, still necessitating certain user actions. By contrast, UWB integration allows the vehicle to recognize and authenticate the driver with greater accuracy and reliability, enabling a truly secure and hands-free, approach-and-enter experience.

From the perspective of consumer surplus, one of the key advantages lie in time savings, reduced effort, and enhanced security. Consider a scenario where a driver currently spends about 80 seconds per day unlocking and starting their vehicle[40]. Over a year, excluding weekends, this translates to approximately 261 days. Multiplying 80 seconds by 261 days yields roughly 20,880 seconds, or about 348 minutes (5.8 hours) spent on these routine interactions. With a UWB digital key, much of this daily overhead can be eliminated, granting the driver immediate access without manual steps.

Adopting the conservative methodology used in previous analyses, assume that only 5% to 10% of these recovered hours are allocated to economically productive activities. Even under such stringent assumptions, the calculation still provides a tangible, lower-bound estimate of consumer surplus. Beyond the quantifiable time savings, intangible benefits, including fewer instances of misplacing keys, diminished stress levels, and greater confidence in consistent vehicle access—further underscore the transformative value that UWB brings to everyday mobility experiences.

Another important dimension of UWB digital keys is their potential to reduce car theft, thereby lowering insurance costs. Traditional keyless entry systems are vulnerable to relay attacks, in which thieves use signal amplifiers to capture and extend the radio frequency from a legitimate key fob located inside a home or office. By contrast, UWB technology employs high-precision distance measurement, making relay attacks far less feasible: a hacker cannot simply amplify the signal because UWB protocols require accurate timing and

[40] We assume 20 seconds, four times per day. While specific studies quantifying the exact time drivers spend unlocking and starting their vehicles are limited, it's reasonable to estimate that these routine tasks consume a portion of the daily time spent in cars. Given that American drivers spend an average of about 61.3 minutes driving each day, allocating approximately 80 seconds per day to unlocking and starting the vehicle seems plausible. Source: https://www.lookupaplate.com/blog/how-much-time-do-americans-spend-in-their-cars/

location checks. Consequently, vehicles secured by UWB digital keys present a significantly lower risk profile for theft, which is a major factor determining auto insurance premiums.

To quantify the impact on insurance rates, the methodology proceeds by estimating the portion of a driver's premium specifically tied to theft risk. Insurance policies typically consider multiple factors—accident history, vehicle type, driver demographics, and theft likelihood—when setting prices. If 10–15% of an average insurance premium is attributable to theft risk, so we can approximate the savings to a fraction of that theft-related premium component. To quantify the monetary impact on insurance premiums, we begin by assuming that 1% of annual income is allocated to auto insurance. Next, we estimate that a 5% reduction in insurance costs can be attributed specifically to the improved theft prevention afforded by UWB's resilience against relay attacks. Multiplying the total insurance expenditure (equivalent to 1% of the driver's income) by 5% then yields a conservative lower-bound figure for annual insurance savings. Although modest on a yearly basis, these savings add up when combined with the overall time-saving benefits and non-monetary advantages of UWB digital keys, ultimately providing a more complete picture of the technology's total consumer surplus.

Although direct monetary gains from reduced premiums are the most quantifiable benefit, intangible advantages further reinforce consumer surplus. A lower theft rate translates into greater peace of mind, diminished anxiety about leaving one's vehicle parked in various locations, and fewer administrative hassles associated with filing police reports or insurance claims. These non-monetary benefits, while not always easy to measure, meaningfully enhance the overall user experience and highlight the broad societal value of transitioning to UWB digital key systems.

Finally, we incorporate these insurance-related savings into the total consumer surplus calculation by adding them to the time-savings benefit described earlier. The result is a more comprehensive measure that reflects both operational convenience and lower risk of theft. Notably, these savings also carry multiplier effects: safer cars reduce strain on law enforcement and judicial resources, and insurers can reallocate risk management efforts toward other areas. Consequently, factoring insurance premium reductions into the consumer surplus presents a more holistic view of how UWB digital keys deliver value to drivers, insurers, and society as a whole.

UWB technology can streamline and secure the process of **confirming a passenger's identity in private transport scenarios** such as ride-hailing or chauffeur services. Traditionally, riders may need to rely on visual cues like license plates, vehicle color, or driver information displayed in an app. Drivers, meanwhile, must often ask the passenger to confirm their name or destination. These steps can lead to brief but frequent delays and potential confusion, especially in crowded or poorly lit environments. As a result, both parties may experience mild frustration and slower onboarding.

By utilizing UWB's high-precision location tracking and authentication capabilities, the identification process becomes more immediate and reliable. As the rider approaches the designated vehicle, the system can verify their identity automatically, eliminating manual confirmations. From a consumer surplus perspective, the chief benefits include time savings, reduced mental effort, and an overall smoother start to the journey. For example, consider a user who currently spends about 20 seconds once a week verifying their driver. Over the course of a year (52 weeks), this totals approximately 1,040 seconds, or around 17.3 minutes of reclaimed time. Implementing UWB-enabled identification could substantially reduce this figure.[41]

Adhering to the conservative approach adopted in previous analyses, assume that only 50% of those with access to this feature actually use it, and only 5% of the recovered minutes yield productive activities. Even under these stringent assumptions, the resulting estimate offers a tangible, lower-bound measure of consumer surplus. Beyond quantifiable time gains, intangible advantages—such as diminished anxiety regarding mistaken vehicle identification, enhanced confidence in service security, and more positive rider-driver interactions—further highlight the transformative potential of UWB in private transport settings. As adoption grows and user familiarity increases, these improvements will likely intensify, elevating service standards and overall user satisfaction.

UWB technology can significantly improve the process of **verifying electronic identities (eIDs) in densely populated mobility-related contexts**. Whether it involves accessing a private parking area at a large event, passing through a checkpoint at a corporate campus, or navigating a busy rideshare pickup zone, traditional ID validation often requires physical documents, manual scans, or inputting credentials multiple times. These conventional approaches can create delays, queues, and occasional confusion, ultimately detracting from user convenience and efficiency.

With UWB-enabled eID validation, identities can be confirmed seamlessly as people pass through access points. This innovation reduces the time and effort associated with conventional ID checks and diminishes the likelihood of errors. From a consumer surplus standpoint, the primary gains include time savings, decreased stress, and a smoother overall experience. Consider a scenario in which a user spends roughly 15 seconds verifying their credentials at an event, and this occurs four times per month. Over time, these small increments accumulate.[42] Implementing UWB-based eID validation can recapture many of these seconds, resulting in shorter lines and more rapid entry processes.

Adhering to the conservative assumptions used in previous analyses, suppose that all individuals with the requisite UWB-enabled devices or credentials use this feature, and that only 5% to 10% of the reclaimed time is applied to truly productive activities. Even under such stringent conditions, the resulting estimate provides a tangible, lower-bound measure

[41] Studies highlight UWB's ability to provide low-latency and accurate proximity-based solutions, enabling seamless interactions between devices and users in dynamic environments (Ghavami et al., 2019). By reducing reliance on manual identification methods, UWB minimizes delays and enhances user satisfaction, addressing common challenges in crowded or poorly lit contexts.

[42] In the context of event entry, studies have shown that traditional identity verification methods can take approximately 7 seconds per person. That time should be increase by the number of persons in the line. This duration can increase in more complex or less controlled environments, potentially leading to longer wait times and decreased efficiency. Source: https://link.springer.com/chapter/10.1007/978-3-030-39878-1_26

of consumer surplus. Beyond these quantifiable improvements, intangible advantages—such as reduced tension at checkpoints, fewer miscommunications, and a more pleasant overall experience—further highlight the transformative potential of UWB technology. As trust in UWB-based eID validation increases and the technology becomes more widespread, these user-centric enhancements will likely intensify, elevating standards across mobility ecosystems and driving greater consumer satisfaction.

UWB technology holds considerable potential for enhancing **Vehicle-to-Everything (V2X) communications and supporting the transition to autonomous driving**. In a fully connected mobility ecosystem, vehicles equipped with UWB can exchange real-time, high-precision location and safety data with infrastructure, other vehicles, and even pedestrians. This increased spatial awareness improves decision-making capabilities, enabling more efficient navigation, collision avoidance, and traffic flow management. While many of the advancements in V2X and autonomous driving primarily serve to bolster safety and reduce accidents—benefits that are undeniably valuable but not directly measured in consumer surplus—there are also tangible time-saving and convenience gains for everyday users.

From a consumer surplus standpoint, these improvements might manifest through fewer traffic disruptions, smoother merging, and more predictable travel times. Consider a scenario in which enhanced coordination among autonomous or semi-autonomous vehicles, enabled by UWB communications, reduces the average commute time by a modest 10 seconds per working day. Over a typical year (261 days, excluding weekends), these incremental savings accumulate to roughly 2,610 seconds, or about 0.73 hours. [43]Applying the conservative methodology used previously, assume that only 5% to 10% of these reclaimed minutes result in genuinely productive activities. Even under such stringent assumptions, the calculation still provides a tangible, lower-bound measure of the consumer surplus delivered by UWB-enabled V2X integration.

It is crucial to acknowledge that these estimates do not encompass the full range of intangible benefits. Reduced driver fatigue, lowered anxiety in complex driving environments, more security and an overall more pleasant travel experience are all qualitative improvements that enhance the value proposition of UWB technology. As the ecosystem matures, and more vehicles and infrastructure elements adopt UWB-based V2X solutions, these user-centric advantages will likely intensify, contributing to a safer, smoother, and more efficient mobility landscape.

UWB technology can facilitate **seamless driverless valet parking and pickup services**, transforming what is often a time-consuming and inconvenient task into a frictionless experience. Traditionally, drivers must locate their vehicles within large, sometimes confusing parking facilities or wait for valet staff to retrieve them. These steps consume valuable time, introduce uncertainty, and can generate frustration, especially during peak usage periods or at busy venues.

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[43] As an example, Shanghai's 5G-Enabled Smart Traffic System (China) generate a 20% reduction in city-wide traffic congestion. Source: https://www.v2x.com/v2x-technology-in-action-real-world-use-cases-and-success-stories/

From a consumer surplus perspective, the chief benefits of this innovation include time savings, reduced stress, and enhanced convenience. For example, consider a scenario in which a driver currently spends about two minutes per week locating their car or waiting for a valet. Over the course of 52 weeks, these incremental delays total approximately 104 minutes, or about 1.73 hours.[44] Implementing UWB-enabled driverless valet services can alleviate much of this routine burden. Applying conservative assumptions, assume that this scenario occurs in only 50% of valet parking events and that just 5%/10% of the recovered hours translate into productive activities. Even under these constraints, the calculation still yields a meaningful lower-bound estimate of consumer surplus.

It is important to recognize that these figures do not capture the full array of intangible benefits. In addition to direct savings, users may experience less frustration, improved satisfaction, and a more streamlined mobility experience overall. As UWB technology matures, becomes more widely available, and earns greater user trust, these qualitative improvements will likely intensify, elevating service standards and reinforcing the transformative impact of UWB-enabled valet solutions on everyday driving and parking scenarios.

The integration of **UWB technology into electric vehicle (EV) charging processes** can streamline and enhance the user experience. Typically, EV drivers must locate suitable charging stations, position their vehicle correctly, authenticate payment methods, and sometimes navigate through multiple steps in a mobile application or touchscreen interface. These tasks, though often minor in duration, can accumulate into notable time and effort over the course of repeated charging sessions.

By leveraging UWB's precise spatial awareness and secure communication features, EVs and charging stations can recognize one another automatically as the vehicle approaches. Payment authentication and session initiation can occur seamlessly, eliminating the need for manual input and allowing drivers to begin charging promptly. From the consumer surplus perspective, the primary benefits center on time savings, reduced cognitive effort, and enhanced convenience. For instance, consider a scenario where a driver currently spends about 30 seconds per charging session on setup tasks and charges their vehicle twice per week.[45] Over a year (52 weeks), this amounts to approximately 3,120 seconds—around 52 minutes.

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[44] Studies indicate that drivers in urban areas spend an average of 17 hours per year searching for parking spaces, equating to approximately 20 minutes per week. While specific data on time spent locating parked cars or waiting for valet services is limited, it is reasonable to infer that these activities contribute to the overall time drivers spend dealing with parking-related tasks. Implementing UWB-enabled driverless valet services could significantly reduce these time expenditures, enhancing convenience and efficiency for users. Source: https://www.usatoday.com/story/money/2017/07/12/parking-pain-causes-financial-and-personal-strain/467637001/

[45] Studies indicate that the average duration of a paid fast-charging session for electric vehicles is approximately 42 minutes. Implementing UWB-enabled systems could streamline the initial setup tasks, potentially reducing the overall time required for each charging session and enhancing user convenience. Source: https://www.energy.gov/eere/vehicles/articles/fotw-1319-december-4-2023-ev-charging-paid-dc-fast-charging-stations-average

Applying a conservative approach, assume that UWB-enabled charging systems are only available and used in 50% of these sessions, reducing the annual time savings to about 26 minutes per driver. Further, suppose that only 5% to 10% of these reclaimed minutes translate into genuinely productive activities. Even under these stringent assumptions, the resulting calculation still provides a tangible, lower-bound measure of consumer surplus.

It is important to acknowledge that these figures do not capture other, less quantifiable advantages. Decreased frustration at payment terminals, shorter waiting times, and an overall more seamless EV ownership experience are all intangible benefits that further elevate the value proposition of UWB integration. As more drivers adopt EVs and UWB-based charging solutions become increasingly prevalent, these user-centric improvements promise to significantly raise standards of convenience and efficiency within the EV ecosystem.

Another potential benefit of UWB in EV charging involves precise vehicle alignment over the charging pad or station. Poor alignment can reduce energy transfer efficiency, but UWB's high-accuracy spatial awareness helps drivers position their vehicles more accurately. Although we do not quantify this aspect in our current analysis, it underscores an additional advantage that could further enhance the EV charging experience.

UWB technology can significantly simplify and expedite **toll collection** processes, reducing the time drivers spend slowing down or stopping at toll booths. In many current systems, travelers must manually interact with payment terminals, rely on transponders that require line-of-sight readers, or wait for cameras to capture license plates for automated billing. These methods can lead to brief delays that accumulate over multiple trips, causing minor but recurring inconveniences and, at times, contributing to congestion around toll plazas.

By integrating UWB into the toll collection ecosystem, vehicles and toll systems can communicate securely and accurately as the car approaches, enabling instantaneous, hands-free payment. From a consumer surplus perspective, this advancement primarily manifests time savings, reduced driver effort, and improved travel predictability. For example, consider a scenario where a driver currently loses about 5 seconds at each toll booth encountered during a typical year (261 days, excluding weekends).[46] Over time, this amounts to approximately 1,305 seconds annually, around 21.75 minutes, or roughly 0.36 hours per year.

Applying conservative assumptions, suppose that only 50% of toll encounters occur where UWB-based systems are implemented, effectively halving the estimated annual time savings

[46] The estimation of 5 seconds spent at toll booths aligns with typical observations in automated tolling environments, such as those employing RFID-based transponders or license plate recognition systems. These systems streamline the payment process compared to manual cash transactions, which can take considerably longer. However, even in optimized scenarios, vehicles often experience brief pauses due to factors like system verification time, traffic conditions, and minor variations in sensor response. Technologies like UWB, with their high-speed and precise communication capabilities, can further minimize these interruptions by enabling instantaneous, seamless transactions without requiring line-of-sight or additional validation steps.

to about 10.88 minutes per driver. Further, assume that only 5%/10% of this reclaimed time is dedicated to genuinely productive activities. Even under such stringent parameters, the resulting calculation provides a tangible, lower-bound measure of consumer surplus.

Beyond these quantifiable gains, additional intangible benefits—such as reduced stress at toll points, more predictable travel times, and smoother overall traffic flow—further enhance the value proposition of UWB integration. As this technology becomes increasingly common and user familiarity grows, these qualitative improvements will likely intensify, ultimately contributing to higher satisfaction and greater efficiency within the mobility landscape.

UWB technology can enable drivers to **open their vehicle trunk effortlessly through a simple gesture**, eliminating the need to search for keys, press buttons, or physically interact with the trunk latch. While some vehicles already offer a foot-swipe feature to open the trunk, these systems can be finicky, occasionally failing if the gesture is not executed perfectly. UWB integration addresses this limitation by enabling more reliable recognition from a greater range of positions, thereby streamlining the process and reducing the risk of multiple attempts or manual interventions.

From the perspective of consumer surplus, the primary benefits include time savings, reduced frustration, and heightened user satisfaction. Consider a scenario where, without UWB, a driver spends roughly one minute per day dealing with trunk access—searching for keys, pressing a button multiple times, or repositioning to trigger a sensor. Over a full year (365 days), this daily effort accumulates to about 365 minutes, or approximately 6.08 hours.[47] By implementing UWB-based trunk-opening features, most of this routine burden can be alleviated, allowing the driver to reclaim a substantial portion of their annual time. Furthermore, assume universal usage among those equipped with this feature and apply a conservative assumption that only 5%/10% of the saved minutes result in genuinely productive activities. Even under these conditions, the estimate still provides a tangible, lower-bound measure of consumer surplus.

It is crucial to acknowledge that these calculations do not capture the full spectrum of intangible benefits. Beyond measurable time savings, UWB integration enhances convenience, minimizes annoyance, and simplifies a common task, contributing to a more pleasant and stress-free driving experience. As UWB technology becomes more common and users grow more accustomed to it, these user-centric improvements are likely to become even more pronounced, reinforcing its transformative potential in everyday mobility scenarios.

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[47] The estimation of one minute per day spent accessing a vehicle trunk is grounded in typical user behavior involving traditional trunk-opening methods. These often include searching for keys, activating buttons, or attempting gestures with foot-swipe sensors, which may require multiple attempts due to sensor misrecognition or obstructions. UWB technology addresses these inefficiencies by offering seamless and reliable trunk access through precise spatial awareness and gesture recognition.

UWB technology can greatly enhance **in-cabin sensing capabilities** within vehicles, enabling more precise detection of occupants, their positions, and their states. Traditional systems rely on seat sensors or basic cameras, which may provide only limited information or struggle in low light conditions. UWB's high-precision spatial awareness allows for more accurate occupant detection—be it identifies if a child is seated in the back, determining if everyone has fastened their seatbelts, or adjusting climate control settings based on where people are located in the cabin. In addition, child presence detection serves as a critical safety application: if a child remains seated in the back, UWB-enabled sensors can identify their exact location and alert the driver or automatically trigger safety measures, reducing the risk of accidental abandonment.

From the standpoint of consumer surplus, the principal benefits include time savings, improved comfort, and enriched safety features. For example, consider a scenario where an occupant currently devotes about two minutes per day to routine adjustments—tweaking seat positions, temperature levels, or infotainment settings. Over the course of a year (365 days), these daily efforts accumulate to approximately 730 minutes, or about 12.17 hours. [48]By leveraging UWB-enabled in-cabin sensing, a significant portion of this time could be saved as the system automatically tailors conditions to known preferences. While these calculations assume that only 5% to 10% of the reclaimed time results in genuinely productive activities, even under such conservative constraints, the estimate still provides a tangible, lower-bound measure of consumer surplus.

It is essential to note that these figures do not fully capture the range of intangible benefits. Reduced distraction, heightened personalization, and a generally more pleasant journey all contribute to a more satisfying travel experience. As UWB technology matures and its capabilities continue to evolve, these user-centric advantages are likely to intensify, further enhancing comfort, convenience, and overall occupant satisfaction in everyday mobility scenarios.

The integration of UWB technology into various mobility use cases—ranging from parking and navigation to vehicle access, payment, and driver assistance—consistently demonstrates tangible consumer surplus. Although the specific time savings or productivity gains may appear modest when measured per individual interaction, their cumulative effect is substantial. By applying conservative assumptions regarding user adoption and productivity rates, and focusing only on quantifiable outcomes, these estimates represent a credible lower bound (See Table 3-8). In practice, the actual benefits are likely greater, as intangible factors—such as reduced stress, improved convenience, and enhanced safety—play a significant role in shaping the overall travel experience.

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[48] One example of the situation is a recent survey that found that couples sharing a vehicle spend several time readjusting settings such as seat positions, mirrors, and climate controls after their partner has driven. Implementing UWB-enabled in-cabin sensing systems can automate these adjustments, reducing the time and effort required for manual readjustments and enhancing overall driving convenience. Source: https://nypost.com/2024/05/22/lifestyle/are-you-car-compatible-with-your-partner/

Table 3-8. Consumer Surplus in Mobility Use Cases

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Parking Garage Access Control	Time Savings	60s/entry or exit, 5x/week → ~4.33 hrs/yr	5% of saved time productive
Indoor Navigation	Time Savings	20s, 2x/week → ~0.58 hrs/yr	5% of saved time productive
Vehicle Digital Key (Car Access)	Time Savings	80s/day, 261 days/yr → ~5.80 hrs/yr	5% of saved time productive
	Cost (Insurance)	5% reduction in insurance costs (assumes 1% of income on insurance costs)	We conservatively estimate only a 5% reduction in insurance costs
Rider Identification in Private Transport	Time Savings	20s/week → ~0.29 hrs /yr	50% use feature; 5% productivity
eID Validation in Crowded Environments	Time Savings	15s/event, 4 events/month	5% of saved time productive
V2X & Autonomous Driving	Time Savings	10s/working day → ~0.73 hrs/yr	5% of saved time productive
Driverless Valet Parking and Pickup	Time Savings	2 min/week → ~1.73 hrs /yr	50% events; 5% productivity
EV Charging	Time Savings	30s/session, 2x/week → ~0.87 hrs /yr	50% sessions enabled; 5% productivity
Toll Collection	Time Savings	5s/day, 261 days/yr → ~0.36 hrs /yr	50% tolls enabled; 5% productivity
Open Trunk with Gesture	Time Savings	1m/day → ~6.08 hrs /yr	All users; 5% productivity
In Cabin Sensing	Time Savings	1m/trip, 2 trips per day → ~12.17 hrs /yr	All users; 5% productivity

NOTE: Although time savings are the primary measure used here, other advantages—such as elevated safety or peace of mind—are not fully monetized. These intangible benefits may, in some cases, outweigh the time-saving gains.
Source: Telecom Advisory Services analysis

As UWB adoption grows, infrastructure matures, and user familiarity increases, the mobility landscape stands to become more user-centric, efficient, and responsive to individual preferences. This evolution promises to elevate travel standards, reduce friction in day-to-day activities, and encourage a more seamless interaction between travelers and transportation systems. Ultimately, UWB's precision, reliability, and versatility position as a pivotal technology in making mobility not just more convenient, but also more rewarding and satisfying for a diverse range of consumers.

3.3.3. Consumer Surplus in individual consumer use cases

Beyond the smart home and mobility environments, UWB technology also delivers substantial value in personal, everyday contexts. Individual consumer use cases revolve around devices that consumers carry on their person or interact with directly—such as smartphones, smartwatches, and other wearable electronics. UWB's precise spatial awareness, robust security features, and seamless connectivity can unlock a variety of enhancements, from more convenient device pairing and faster data transfers to personalized, context-aware functionalities.

From the consumer surplus perspective, these improvements often translate into more intuitive interactions, reduced time spent performing routine tasks, and a heightened sense of security and reliability. For instance, a UWB-enabled smartphone can automatically configure itself to the user's surroundings, locate other devices effortlessly, or initiate secure payment transactions without the need for manual inputs. Over time, these enhancements accumulate into meaningful savings—measured not only in hours and monetary terms, but also in reduced frustration and improved user experiences.

As with other categories, understanding the consumer surplus in individual consumer use cases requires careful estimation and conservative assumptions. Factors such as device adoption rates, variations in user behavior, and evolving technological standards all influence the magnitude and distribution of benefits. Still, by focusing on quantifiable dimensions—like time savings, convenience, and security improvements—it is possible to derive robust lower-bound estimates. Through this methodology, we can highlight the transformative potential of UWB technology in everyday consumer applications, capturing its capacity to simplify routines, enhance personal productivity, and improve quality of life.

UWB-enabled smart watches represent a natural progression in the integration of wearable technology into daily life. Compared to traditional watches or even earlier generations of smart wearables, devices equipped with UWB can leverage precise spatial awareness and seamless connectivity to deliver a range of enhanced functionalities. This may include instant device recognition for easier pairing, more reliable and location-aware payment transactions, and the ability to find other personal devices (such as smartphones or earbuds) quickly and efficiently without resorting to manual searches.

From a consumer surplus perspective, the key advantages manifest as time savings, greater convenience, and incremental gains in personal security and peace of mind. Consider a scenario in which a user currently spends approximately four minutes per day addressing tasks that UWB could streamline, such as resolving connectivity issues or finding misplaced devices.[49] Over one year, these small daily efforts accumulate to roughly 1,460 minutes, or about 24.33 hours. By incorporating UWB, a significant portion of this time could be reclaimed through automation and more intuitive device interactions.

Adhering to a conservative approach, suppose that only half of users with UWB-enabled watches fully employ these features. Under this assumption, the average annual time savings per user (across the entire user base) decreases to about 12.17 hours. Further, assume that just 5%/10% of these reclaimed hours lead to truly productive activities. Multiplying this fraction by an hourly wage provides a tangible, lower-bound estimate of the economic value derived from UWB integration. It is essential to acknowledge that these calculations do not

[49] A study by Electric.ai found that employees spend nearly three hours per week resolving technical issues, including connectivity problems and locating misplaced devices, amounting to over 140 hours annually. These figures highlight the significant time burden imposed by routine technical challenges. When considering the specific use case of smartwatches, the estimated time spent—four minutes per day addressing connectivity issues, searching for paired devices, or troubleshooting—is a highly conservative estimate. Source: https://www.electric.ai/blog/wasted-talent-time-lost-to-tech-issues

encompass all of the technology's impacts. Beyond measurable time savings, UWB-enabled smart watches can alleviate everyday aggravations, enhance user confidence in their devices, reduce cognitive strain, and foster a more seamless interplay between wearables and the broader technological ecosystem. While such intangible improvements defy straightforward quantification, they substantially enrich the user experience and contribute meaningfully to the transformative potential of UWB technology in daily life.

UWB-enabled smartphones represent a natural extension of the mobile ecosystem's ongoing evolution toward more seamless and context-aware functionalities. Beyond the standard features of calling, messaging, and browsing, UWB integration elevates the smartphone into a central hub for precise location tracking, secure and effortless device pairing, and frictionless transactions. For example, a UWB smartphone can identify the position of nearby devices with centimeter-level accuracy, enable hands-free connections to audio systems or personal electronics, and facilitate contactless payment with minimal user intervention, reducing the time and cognitive effort typically associated with these daily tasks.

From a consumer surplus perspective, the resulting improvements predominantly manifest as time savings, greater convenience, and an overall enhanced user experience. Consider a scenario where a user currently devotes about three minutes per day to connectivity-related activities—such as adjusting Bluetooth settings or repeatedly confirming payments—that UWB could streamline.[50] Over the course of a year, these three minutes per day accumulate to approximately 1,095 minutes (18.25 hours). By leveraging UWB capabilities, a substantial portion of this time can be reclaimed, allowing users to invest their energy in more meaningful or productive pursuits.

To remain conservative, assume that only half of UWB-capable smartphone users fully employ these functionalities, reducing the average annual time savings across all users to about 9.13 hours. Further, suppose that only 5%/10% of this recovered time is applied to productive activities, and approximate its monetary value using a suitable hourly wage. It is important to underscore that these calculations do not encapsulate the full spectrum of advantages enabled by UWB. Beyond measurable time savings, UWB integration diminishes the cognitive load of routine tasks, instills greater user confidence in device interactions, and fosters a more harmonious relationship between smartphones and the surrounding digital environment. These intangible improvements, though less readily quantified, substantially enrich the user experience and emphasize the transformative potential of UWB technology in everyday mobile life.

In the context of individual consumer devices, UWB technology offers clear advantages that extend beyond traditional functionalities. As seen with smart watches and smartphones,

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[50] Considering the findings highlighted in the smartwatch use case, where users spend an estimated four minutes per day addressing connectivity issues or locating misplaced devices, the three-minute estimate for smartphones is notably conservative. Smartphones typically serve as primary devices for a broader range of activities, such as managing Bluetooth connections, confirming contactless payments, and pairing with other devices, which are more frequent and complex than similar tasks on smartwatches.

even small daily time savings accumulate over a year, providing tangible economic value when assessed under conservative assumptions. While only a fraction of users might fully leverage these features, and only a portion of the saved time may translate into productive activities, these figures still represent a meaningful lower bound on the consumer surplus enabled by UWB (See Table 3-9). Furthermore, these estimates do not capture the intangible benefits—such as enhanced security, reduced cognitive effort, and improved overall user satisfaction—that often accompany UWB integration. As the technology matures and adoption rates increase, the potential for more significant and widely distributed consumer surplus in everyday personal devices becomes increasingly apparent.

Table 3-9. Consumer Surplus in Individual consumer Use Cases

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Smart Watches	Time Savings	~24.33 hours/user/year (if all fully adopt features)	~12.17 hours/user/year (50% adoption) → ~0.61 hours/user/year (5% productivity)
UWB Smartphones	Time Savings	~18.25 hours/user/year (if all fully adopt features)	~9.13 hours/user/year (50% adoption) → ~0.46 hours/user/year (5% productivity)

Source: Telecom Advisory Services analysis

3.3.4. Consumer Surplus in Public transportation use cases

Public transportation systems are critical components of urban infrastructure, enabling efficient and affordable mobility for a diverse range of passengers. Whether commuting to work, traveling for leisure, or navigating unfamiliar cities, individuals rely on these systems for timely, cost-effective, and reliable service. UWB technology has the potential to improve the public transportation experience by enhancing ticket validation processes, streamlining fare payment, improving navigation and seat allocation, and facilitating more precise location-based services. As a result, UWB implementation can deliver tangible consumer surplus by reducing delays, minimizing passenger frustration, and improving overall travel satisfaction.

From the perspective of consumer surplus, the benefits derived from UWB integration in public transportation extend beyond simple time savings. By enabling more accurate crowd management, better route planning, and smoother intermodal transitions, these enhancements can reduce waiting times, decrease congestion, and increase the predictability of travel. Passengers may experience lower stress, improved safety, and more confidence in the reliability of their chosen mode of transport. Over time, these improvements translate into quantifiable gains—measured in both hours saved and the avoided costs of missed connections or last-minute itinerary changes.

It is important to recognize that the magnitude and distribution of consumer surplus within public transportation contexts depend on various factors, including adoption rates, infrastructure maturity, and regional transportation policies. Furthermore, not all passengers will access or fully exploit UWB-enabled features. By applying the same conservative principles and focusing on measurable outcomes, however, analysts can derive robust, lower-bound estimates of the additional value passenger's gain. In doing so, this section highlights the role that UWB technology can play in shaping more efficient, secure, and user-friendly public transportation systems.

UWB-enabled ticket validation in public transportation systems improves the passenger experience by automating and streamlining entry processes. Traditionally, travelers must present physical tickets, scan QR codes, or tap contactless cards at turnstiles or entry gates—an action that can lead to queues, especially during peak hours. With UWB technology, these validations can occur seamlessly as passengers approach access points, reducing wait times and minimizing delays for both the individual user and subsequent travelers.

From a consumer surplus perspective, the primary gains lie in time savings and reduced inconvenience. Consider a daily commuter who makes two trips per weekday—one to work and one back—and currently spends about 15 seconds per trip verifying their ticket. Over a year of 261 days (excluding weekends), this daily expenditure of 30 seconds accumulates to approximately 7,830 seconds, or about 2.18 hours.[51] By implementing UWB-based ticket validation, most of these 2.18 hours can be reclaimed, allowing passengers to pass through entry points with minimal effort.

To maintain a conservative approach, assume that only 10% of passengers utilize UWB-enabled ticketing services. Under this assumption, the average annual time savings per passenger—considering all passengers, not just adopters—drops to about 0.22 hours (2.18 hours × 10%). Furthermore, assume that only 5%/10% of these regained hours are allocated to genuinely productive activities. Even with these layers of conservatism, the calculation still provides a tangible, lower-bound estimate of consumer surplus derived from more efficient ticket validation.

It is essential to recognize that these figures do not encompass all the advantages brought by UWB integration. Beyond measurable time savings, improved crowd flow, reduced stress from shorter queues, and a more satisfying travel experience collectively enhance the overall value proposition. As UWB-based ticket validation becomes more commonplace and passengers grow increasingly accustomed to it, the cumulative consumer surplus across the entire user base stands to increase substantially, further underscoring the transformative potential of this technology in public transportation environments.

UWB technology can enhance the passenger experience in public transportation by simplifying **reserved seat validation**. On trains, buses, and other modes of long-distance or regional travel, passengers often pay for seats in specific locations. Under traditional systems, verifying that passengers are seated correctly may involve conductors manually checking tickets, or travelers themselves spending time confirming their seat numbers and

[51] The estimate of 15 seconds per trip for ticket verification is conservative, as routine actions like scanning a QR code or tapping a card often involve slight delays due to user positioning or system responsiveness. UWB technology, by enabling automatic and seamless validation, has the potential to eliminate these minor but frequent inefficiencies. Source: https://www.infineon.com/cms/en/product/promopages/mobility-in-motion/ultra-wide-band/

comparing them against seat labels. This process can lead to confusion, delays, and occasional disputes—particularly in crowded or unfamiliar settings.

By integrating UWB, seat validation becomes both automated and more accurate. As passenger boards, the system can instantly confirm that the individual is seated in the correct reserved spot, reducing the need for manual verification or intervention. From a consumer surplus perspective, this improvement primarily translates into time savings, reduced stress, and a smoother travel experience. Consider a scenario where a passenger currently spends about one minute per journey verifying their seat.[52] Over the course of 120 trips per year, this totals approximately 120 minutes. Implementing UWB validation could significantly diminish these verification efforts, returning most of those two hours to the passenger.

To maintain conservatism, assume that only 10% of passengers have access to and use these UWB-enabled seat validation features. Under this assumption, the average annual time savings per passenger (across all travelers, not just adopters) drops to about 12 minutes (120 minutes × 10%). Further, assume that merely 5%/10% of these reclaimed minutes result in genuinely productive activities. Even under these constraints, the calculations provide a tangible, lower-bound measure of consumer surplus from eliminating seat-related confusion and delays.

It is important to acknowledge that these figures do not encompass every dimension of value created by UWB integration. Beyond measurable time savings, intangible benefits—such as greater peace of mind, fewer misunderstandings over seating assignments, and a more harmonious atmosphere—also enhance the perceived value of the travel experience. While more challenging to quantify, these qualitative improvements contribute substantially to the transformative potential of UWB technology in reserved seat validation settings.

UWB-enhanced ride sharing introduces a new level of accuracy and convenience into the process of matching passengers with their vehicles. Traditionally, individuals hailing a ride share service must rely on GPS signals and visual identification—scanning a busy street for the correct vehicle, comparing license plates, or exchanging phone calls or messages with the driver. These steps can introduce delays and frustration, particularly during peak hours or in crowded urban environments where multiple vehicles from the same service may be present.

By employing UWB's high-precision location capabilities, passengers and drivers can identify each other's exact positions in real time, minimizing the effort and time spent confirming the correct vehicle. From a consumer surplus standpoint, the key advantages lie in time savings, reduced cognitive effort, and diminished stress. For example, consider a user

[52] The estimate of one minute per journey for seat validation is conservative, as routine tasks such as locating seat numbers, confirming assignments, or resolving minor misunderstandings can often take longer, especially in crowded or unfamiliar settings.

who currently spends about two minutes per ride verifying their car.[53] With two rides per week, this amounts to roughly 208 minutes per year (approximately 3.47 hours). Incorporating UWB positioning could reclaim much of this time, allowing passengers to locate their vehicles more directly and efficiently.

To remain conservative, assume that only 10% of ride share passengers utilize devices or platforms supporting UWB positioning. Under this assumption, the average annual time savings per passenger (considering all passengers) fall to around 0.35 hours (3.47 hours × 10%). Further, suppose that only 5%/10% of these recovered hours translate into productive activities. Even with these cautious constraints, the calculation still provides a tangible lower-bound estimate of the consumer surplus arising from more accurate ride matching.

It is important to recognize that these figures do not fully encompass the scope of UWB's impact. Beyond quantifiable time savings, intangible improvements—such as less frustration, fewer communication errors, and an overall smoother travel experience—also enhance consumer welfare. While more challenging to measure, these qualitative gains further underscore the transformative potential of UWB integration, encouraging a more user-centric and efficient ecosystem for public transportation and ride sharing services.

UWB integration in bike and scooter sharing services can significantly improve the user experience by enabling precise and instant location tracking. Currently, individuals often spend time searching for available bikes or scooters in designated docking stations or scanning crowded sidewalks to locate free-floating units. This process can involve walking extra blocks, consulting mobile maps multiple times, or even giving up if no readily visible option is found. Such inefficiencies introduce friction into the experience, potentially discouraging use and increasing travel times.

With UWB's high-precision positioning, users can swiftly identify the exact location of the nearest available bike or scooter, often reducing a multi-minute search to mere seconds. From the consumer surplus perspective, the primary gains include time savings, lower effort, and heightened convenience. Consider a scenario where a user currently spends about two minutes per trip searching for a device.[54] On three trips per week, this adds up to approximately 312 minutes per year (about 5.2 hours). By implementing UWB-enabled vehicle finding, a significant portion of this time could be reclaimed, promoting faster, more efficient short-distance travel.

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[53] The estimate of two minutes per ride spent verifying the correct vehicle in ride-sharing services is conservative. In busy urban environments, identifying the right car often involves scanning multiple vehicles, checking license plates, and possibly communicating with the driver, which can easily exceed two minutes, especially during peak hours or in crowded areas.

[54] The estimate of two minutes per trip spent searching for shared bikes or scooters is conservative. In urban settings, locating an available device often involves navigating crowded areas, consulting mobile apps, and walking to the precise location, which can easily exceed two minutes, especially during peak usage times or in areas with high demand.

To remain conservative, we assume that only 10% of sharing service users possess devices compatible with UWB positioning. Under these conditions, the average annual time savings per user (across the entire user base) decreases to roughly 0.52 hours (5.2 hours × 10%). Further, suppose that just 5%/10% of these regained hours result in genuinely productive use. Even under these layered conservative assumptions, the calculation still yields a tangible lower-bound estimate of consumer surplus stemming from improved bike and scooter discovery.

It is essential to recognize that these figures do not fully capture all the advantages of UWB integration. Beyond measurable time savings, intangible benefits—such as less frustration, higher user satisfaction, and the potential for increased adoption rates—further highlight the transformative potential of this technology. As UWB solutions become more commonplace and users grow more accustomed to their capabilities, the ability to streamline transportation sharing and enhance urban mobility ecosystems will likely become increasingly pronounced.

UWB integration in public transportation fare payment systems can streamline and simplify the process of paying for rides. Instead of fumbling with physical tickets, waiting in lines at vending machines, or repeatedly tapping a card against a reader, passengers can pay their fares automatically as they enter or exit vehicles, or as they pass through designated access points. The system would leverage precise location data to confirm that a user is in or near a vehicle or station, ensuring accurate and secure fare collection without manual input.

From a consumer surplus perspective, the key benefits of UWB-enabled fare payment are time savings and decreased inconvenience. Consider a passenger who currently spends about 15 seconds per trip confirming their fare. Over 522 trips per year (assuming two trips each day, excluding weekends), these brief intervals sum to approximately 7,830 seconds, or around 130.5 minutes.[55] By implementing UWB-based fare payment, a substantial portion of these delays could be reclaimed, allowing users to move seamlessly through their journeys without pausing for manual ticketing steps.

To maintain a conservative approach, assume that only 10% of passengers have access to and actively use UWB-enabled payment features. Under this assumption, the average annual time savings per passenger—considering the entire user base—diminishes to about 13 minutes (130.5 minutes × 10%). Further, suppose that only 5%/10% of these reclaimed minutes are dedicated to genuinely productive activities. While these layered conservatisms significantly lower the estimated benefit, the resulting calculation still provides a meaningful, lower-bound measure of consumer surplus from more efficient fare transactions.

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[55] Integrating UWB technology into public transportation fare systems can significantly reduce the time passengers spend verifying tickets. Traditional methods, such as scanning QR codes or tapping cards, often require manual interaction, leading to delays, especially during peak hours. UWB enables seamless, contactless fare validation as passengers approach access points, minimizing these delays. Considering that current ticket verification processes can take several seconds per passenger, the estimate of saving 15 seconds per trip with UWB integration is conservative. Source: https://www.firaconsortium.org/sites/default/files/2023-07/the-UWB-revolution-for-transport-fare-collection-july-2023.pdf

It is crucial to acknowledge that these figures do not capture all the improvements brought about by UWB integration. Beyond quantifiable time savings, intangible enhancements—such as reduced crowding and confusion at payment terminals, diminished stress from ticketing delays, and a smoother, more pleasant travel experience—amplify the value proposition of UWB-based solutions. As more passengers and transportation operators embrace these innovations, the cumulative benefits—both measurable and intangible—will likely grow, further demonstrating the transformative potential of UWB technology in public transportation ecosystems.

The incorporation of UWB technology into public transportation use cases—ranging from ticket validation and reserved seating to ride sharing and fare payment—demonstrates a tangible potential for enhancing the passenger experience. While the estimated time savings and productivity gains may appear modest per individual, these improvements accumulate across entire networks and passenger populations, leading to significant aggregate benefits (See Table 3-10). Moreover, the conservative assumptions employed here focus only on direct, quantifiable metrics. In practice, the impact of UWB integration extends beyond mere time savings to include reduced stress, improved user satisfaction, and greater confidence in the reliability and convenience of public transport services. As adoption grows and UWB-enabled features become standard, public transportation systems may evolve into more user-centric, efficient, and pleasant mobility solutions, further increasing the consumer surplus enjoyed by travelers.

Table 3-10. Consumer Surplus in Public transportation Use Cases

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Ticket Validation	Time Savings	~2.18 hours/passenger/year	~0.22 hours/passenger/year → ~0.011 hours/passenger/year
Reserved Seat Validation	Time Savings	~2 hours/passenger/year	~0.2 hours/passenger/year → ~0.01 hours/passenger/year
Ride Sharing (Precise Positioning)	Time Savings	~3.47 hours/passenger/year	~0.35 hours/passenger/year → ~0.0175 hours/passenger/year
Transportation Sharing (Bike/Scooter)	Time Savings	~5.2 hours/passenger/year	~0.52 hours/passenger/year → ~0.026 hours/passenger/year
Transportation Fare Payment	Time Savings	~2.175 hours/passenger/year	~0.2175 hours/passenger/year → ~0.0109 hours/passenger/year

Source: Telecom Advisory Services analysis

It is also worth noting that certain additional use cases—like "Indoor navigation for out-of-town travelers"—were excluded to maintain a clear focus on the main mobility applications and prevent double counting. Although such scenarios could offer distinct consumer benefits, they often overlap with the broader indoor navigation or ride-sharing use cases already captured in the model. By limiting the analysis to the most representative and distinct applications, the study provides a conservative yet accurate estimation of UWB's consumer surplus in the public transportation context.

3.3.5. Consumer Surplus in Smart building use cases

Smart building environments leverage UWB technology to optimize access, operations, and occupant safety. Unlike consumer-oriented smart home solutions, which focus largely on convenience and personal comfort, smart building applications address a broader range of functionalities that benefit both individuals and organizations. These include more efficient access control systems, enhanced building security, and improved emergency management protocols. By delivering these advantages, smart buildings foster an environment that reduces stress, increases productivity, and enhances the overall user experience for employees, visitors, and facility managers alike.

From the consumer surplus perspective, the core value proposition of UWB in smart buildings is the ability to streamline daily interactions within these spaces. For occupants, this may manifest as reduced waiting times at entry points, fewer security-related disruptions, or more coordinated responses to emergencies. These improvements extend beyond mere time savings; they also encompass tangible increases in well-being, safety, and peace of mind. By assessing metrics such as reduced downtime, enhanced safety measures, and the mitigation of workplace stress, analysts can approximate the economic value users derive from UWB-enabled smart building features.

Before delving into specific use cases, it is important to note that quantifying consumer surplus in smart buildings may be more complex than in residential settings. This complexity arises from the diverse range of building types—offices, campuses, commercial facilities—and the varied stakeholders involved. Nevertheless, by applying consistent, conservative assumptions and focusing on measurable outcomes, we can generate a robust and scalable framework to estimate the consumer surplus associated with UWB integration in smart building contexts.

In the realm of smart buildings, UWB-enabled **physical access control** systems significantly enhance security and operational efficiency. Traditional card-based or key-based entry systems require manual verification and can lead to delays as users fumble for their credentials or struggle with malfunctioning badges. By contrast, UWB-supported access control uses precise location tracking and authentication protocols to allow seamless, hands-free entry for authorized individuals. This reduces queues, alleviates congestion at peak times, and ensures that people move quickly to their workstations, meeting rooms, or service areas.

The primary benefits to building occupants manifest as convenience, time savings, and a subtle yet meaningful improvement in their daily workflow. Consider, for instance, that an employee might spend 30 seconds per entry scanning a badge or swiping a card and does so an average of four times per day. Over the course of a year (assuming 261 days, excluding weekends), this amounts to 522 minutes, or about 8.7 hours of cumulative access-related delays.[56] By implementing UWB-based physical access control, these interactions can be

[56] Traditional key card access systems require users to manually present their credentials to a reader, a process that can take several seconds or minutes per entry. Over multiple daily entries, this time accumulates, leading

reduced to near-zero, allowing employees to gain entry immediately without manual authentication steps. To maintain a conservative estimate, we also assume that only 5% of employees use a formal check-in process and would therefore be the primary beneficiaries of this improvement.

Also, to maintain the conservative approach of previous use cases, one might assume that only 5%/10% of these saved hours could be converted into extra earnings for the workers. If we also acknowledge that building occupants vary in how frequently they access different zones, this figure provides a lower-bound estimate of the potential productivity gains. Although these calculations do not capture the broader benefits of less stressful or more secure environments, they provide a tangible, scalable framework for estimating consumer surplus from enhanced physical access control in smart building settings.

While physical access control focuses on simplifying the entry process for building occupants, **controlled access** refers to the dynamic regulation of who can enter specific areas or access particular resources within the building at certain times. This may include restricting access to high-security zones, sensitive document archives, data centers, or specialized equipment rooms. UWB-enabled controlled access not only confirms an individual's credentials but also continuously verifies their location and authorization level. This ensures that only those with proper clearance can remain in restricted areas, thereby reducing unauthorized presence and improving asset protection.

From a consumer surplus perspective, controlled access yields benefits that are more nuanced than the clear time savings seen in physical access control. Instead of merely speeding up standard entry, controlled access enhances overall organizational efficiency and peace of mind. Consider employees who regularly need entry to sensitive areas (e.g., IT staff entering server rooms, R&D personnel accessing prototype labs). Under traditional methods—such as manual keys, sign-in sheets, or recurring security checks—these employees might spend about 10 minutes per week dealing with these access procedures. Over 50 working weeks, that's approximately 500 minutes, or around 8.33 hours per year. By streamlining and automating this process with UWB, most if not all of these 8.33 hours could be reclaimed, ensuring smoother workflows and fewer operational barriers.

To remain conservative, we assume that only 5% of the building's employees require such controlled access frequently and therefore stand to benefit directly from these savings. Additionally, we maintain that only 5%/10% of these regained hours translate into extra productive work or earnings. Although these conservative figures focus solely on direct time recovery and do not fully capture the broader advantages—such as enhanced security, greater employee satisfaction, and reduced risks associated with sensitive information handling—this approach provides a tangible, lower-bound framework for estimating the

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to potential delays and reduced efficiency. UWB technology enhances access control by enabling seamless, hands-free entry, allowing authorized individuals to gain access without physical interaction. Source: https://www.supremainc.com/en/hub/insights-next-generation-security-how-UWB-changing-access-control.asp consumer surplus generated by UWB-enabled controlled access in smart building environments.

UWB technology can significantly improve emergency response procedures within smart buildings by enabling precise real-time tracking of occupants (**Employee gathering in emergencies**). In the event of a fire, earthquake, or other critical incident, building management and emergency personnel need to confirm that all individuals have safely evacuated or reached designated assembly points. Traditionally, this verification may involve manual headcounts, checking paper-based lists, or communicating via walkie-talkies—processes that are not only time-consuming but also prone to human error and confusion.

From a consumer surplus perspective, the principal gains stem from time savings, reduced stress, and potentially lower risks to personal safety. For example, consider a scenario where a building houses 500 employees, and in an emergency drill or actual event, it might take 20 minutes to confirm everyone's presence at assembly points using traditional methods. This delay not only heightens anxiety but also occupies employees' and security personnel's time. With UWB-enabled tracking, confirming occupancy and ensuring everyone is accounted for could reduce this verification time, cutting it down to about 5 minutes.

While 15 minutes saved per emergency event may seem minor on an individual basis, scaling it across multiple drills or incidents per year, and across all building occupants, reveals a substantial collective gain. To maintain a conservative stance, assume that only one drill or emergency event takes place annually and that only 5%/10% of the saved time translates into productive work or other tangible economic value. Although this method does not fully capture the intangible benefits—such as enhanced peace of mind, reduced panic, and lower potential for injury—it provides a measurable, lower-bound framework for assessing the consumer surplus from UWB-driven improvements in emergency management within smart buildings.[57]

In smart building environments, UWB technology delivers measurable consumer surplus by enhancing access control, streamlining operations in sensitive areas, and improving emergency response protocols. Although these improvements may seem modest on an individual basis, their cumulative impact—when scaled across large buildings, multiple facilities, and varying stakeholder groups—can be substantial. By applying conservative assumptions regarding user adoption and the proportion of saved time that translates into productive activities, these estimates represent a lower bound on the potential benefits (See Table 3-11). Beyond direct time savings and increased operational efficiency, the presence of UWB-enabled systems also contributes to intangible gains such as enhanced safety, reduced anxiety, and improved overall workplace experience. As adoption grows and these technologies mature, the potential for more significant and widespread consumer surplus in smart buildings becomes increasingly evident.

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[57] Zhou, Shiyi & Chen, Danhong & Ming, Chengzhuo & Zhang, Rui & Bai, Shuwen & Li, Tong. (2023). *Fire Evacuation System Based on UWB Indoor Positioning Technology and Small Program*.

Table 3-11. Consumer Surplus in Smart Building Use Cases

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Physical Access Control	Time Savings	~8.7 hours/user/year (for those checking in)	Only 5% of employees benefit; 5% of saved time is productive
Controlled Access	Time Savings	~8.33 hours/user/year (for employees requiring restricted access)	Only 5% of employees benefit; 5% productivity of saved time
Employee Gathering in Emergencies	Time Savings	Reduces verification time from ~15 min/event (for all occupants)	1 event/year; 5% productivity of saved time

Source: Telecom Advisory Services analysis

3.4. Disaggregation of worldwide results by country

The global impact assessments presented thus far gain further clarity when broken down at the country level, revealing the distinct economic and societal contributions of UWB technology in specific regions. Because local market conditions exert a powerful influence on how UWB is adopted, it is essential to analyze each geography individually. This disaggregation allows for a more precise understanding of where UWB-driven growth can be most pronounced and which industries or consumer segments stand to benefit the most.

After calculating total worldwide revenues for each primary UWB application area, the next step was to allocate these global figures across countries and regions. As previously mentioned, smartphone-related use cases were distributed based on adoption and penetration data from GSMA Intelligence, ensuring that the number of UWB-capable devices reflected each market's mobile ecosystem dynamics. Similarly, vehicle-related use cases—such as in-vehicle payment or digital key applications—were allocated using car sales data from the OICA. Finally, industrial use cases relied on GDP projections from the IMF to capture each country's relative share of global output.

This geographic allocation guided the estimation of UWB units. By applying sector-specific distribution criteria, the analysis accounts for the differences in maturity, consumer spending power, and industrial capacity across diverse economies. For example, advanced markets with robust smartphone penetration and high consumer purchasing power showed an outsized share of UWB-enabled smartphone adoption. Conversely, emerging markets displayed a slower initial ramp-up but are positioned for potentially faster relative growth once infrastructure and consumer awareness align.

Another critical dimension of country-level disaggregation involved employment impact, calculated via national Input/Output matrices. By tracing how new UWB-related output in one sector induces additional labor demand in interconnected industries, each economy's specific I/O structure helped determine how many direct, indirect, and induced jobs would result. Hence, while the global aggregate jobs figure highlights the scale of UWB's labor market contributions overall, breaking these down by country underscores how local supply chain configurations and labor productivity affect the number of job-years created in each geography.

In parallel, both producer surplus and consumer surplus were initially determined on a country-by-country basis, reflecting the unique variables of hourly wages and the ratio of enterprises to total population. For instance, advanced economies could exhibit higher productivity gains or hourly wages, thus generating a more substantial producer surplus per unit of saved labor time. Conversely, certain emerging markets may show a lower wage baseline but demonstrate notable consumer surplus gains as soon as UWB-enabled services begin to roll out at scale. Only after finalizing these country-specific calculations were the results consolidated into the overall global analysis.

Taken together, this multi-pronged method of disaggregation—covering device units, revenues, job creation, and surplus—offers a detailed view of how UWB's benefits vary across geographical contexts. It illuminates which regions are most likely to adopt specific UWB use cases first, where the greatest employment gains might occur, and how consumer and producer surpluses scale in different economic landscapes.

3.5. Conclusion

This section concludes the methodology chapter by summarizing the primary takeaways from the preceding analyses and consolidating the key use case impact metrics that will underpin the economic calculations in subsequent chapters. Throughout Sections 3.1 to 3.4, we examined how UWB drives socio-economic benefits along four major dimensions— GDP contribution, job creation, producer surplus, and consumer surplus—while highlighting the methodological underpinnings used to derive these results at both a global and country-specific level.

For the purpose of estimating GDP contribution, building on the hardware and software adoption estimates, this analysis captures the total revenue that UWB-enabled applications generate across seven broad areas, thereby quantifying UWB's overall effect on global output. Throughout this study, we assume that UWB device adoption is driven by projected shipments of key hardware components—chipsets, tags, and anchors. We map these shipments to real-world deployment in use cases such as mobility, smart retail, and industrial automation. This mapping informs the overall penetration figures and underlies our calculations for GDP contribution, job creation, and surpluses.

By tracking Chipset, TAG, and Anchor sales, software integration, and regional allocations (guided by metrics such as GSMA smartphone adoption and OICA vehicle sales), the methodology translates individual use cases into an aggregate measure of how UWB adoption shapes the revenue generated. This provides a robust lens for understanding how UWB's introduction can create new market segments and ultimately drive sustained economic growth over time.

By relying on Input/Output analysis, the study further shows how each dollar of UWB revenue reverberates throughout interconnected sectors, effectively mapping the ripple effects that UWB-induced output exerts on overall employment. In distinguishing between direct, indirect, and induced jobs, it underscores both the immediate technical roles—such as device integration and software development—and secondary positions made possible by broader consumption patterns. The result is a clear picture of how UWB stimulates labor market expansion, particularly as regional infrastructures mature and consumer demand rises.

For the purpose of estimating producer surplus, from automating inventory checks in Smart Retail to optimizing location tracking in Industrial contexts, the technology brings about tangible operational gains that translate into lower production costs, reduced downtime, and heightened supply chain visibility—together referred to as producer surplus. Rather than simply increasing sales volumes, this metric captures the extra profit margin realized when UWB replaces manual processes and delivers real-time data insights. These developments underscore the solid business case for continuous UWB investment across various sectors (see Table 3-12).

Table 3-12. Producer Surplus Methodology

Use Case	Hours Saved Annually	Key Efficiency Gain
Tap-Free Mobile Payment	0.98	Reduces transaction time for faster checkouts
Unmanned Store Access	16.52	Automates customer entry and checkout processes
Foot Traffic and Shopping Behavior Analytics	16.52	Accelerates insights from customer movement data
Exhibition Attendee Management	14.00	Simplifies check-in and engagement tracking
Targeted Marketing	8.26	Reduces time spent tailoring campaigns
Drone-Controlled Delivery	8.26	Improves delivery accuracy and reduces manual handling
In-Vehicle Payment	1.77	Speeds up tolls and parking payments
Indoor Navigation	23.60	Reduces time spent locating specific areas or equipment
Proximity-Based Patient Data Sharing	23.60	Automates patient data retrieval for improved workflows
Teleconference Systems	11.80	Simplifies meeting setup and reduces delays
Patient Tracking	35.40	Real-time location updates for efficient patient management
Industrial Real-Time Location Systems	70.80	Automates asset and inventory tracking processes

Source: Telecom Advisory Services analysis

Finally, for the purpose of measuring consumer surplus, everyday users benefit through improvements such as hassle-free mobile payments, seamless smart home device integrations, and more efficient transit experiences. These gains measure the additional value individuals receive beyond any direct outlay—whether in time savings, reduced stress, or minimized friction in digital interactions. As advanced functionalities like presence-based activation or auto-unlocking vehicle doors gain traction, end-users enjoy growing day-to-day conveniences, reinforcing the transformative effects of UWB's rapid integration into daily tasks and routines (see Table 3-13).

Table 3-13. Consumer Surplus Methodology

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Point and Trigger Control App	Time Savings	~12.17 hours/user/year	~0.61 hours/user/year (after 5% adoption/use) → ~0.030 hours/user/year (5% productivity of that time)
Residential Access Control	Cost (Insurance)	~5-10% reduction in property insurance costs (assumes 1% of income on insurance costs)	Same percentages (5% high-income regions, 10% lower-income), no further scaling applied
Easy (Logistical) Access to Personal Devices	Time Savings	~13 hours/user/year	~13 hours/user/year → ~0.65 hours/user/year (5% productivity of that time)
All Gaming	Time Savings	~60.83 hours/user/year	~3.04 hours/user/year (5% adoption) → ~0.152 hours/user/year (5% productivity of that time)
Audio Streaming	Time Savings	~12.17 hours/user/year	~0.61 hours/user/year (5% productivity)
Gesture-Based Control	Time Savings	~18.25 hours/user/year	~0.91 hours/user/year (5% productivity)
VR Gaming and Group Play	Time Savings	~17.3 hours/user/year	~0.865 hours/user/year (5% productivity)
Find Someone/Something Nearby	Time Savings	~17.3 hours/user/year	~0.865 hours/user/year (5% productivity)
Smart Speaker	Time Savings	~18.25 hours/user/year	~0.91 hours/user/year (5% productivity)
Presence-Based Device Activation	Cost (Energy)	~5% reduction in energy costs (assumes 1% of income on energy)	Same percentage (5% of that 1% income), no further scaling applied
Parking Garage Access Control	Time Savings	60s/entry or exit, 5x/week → ~4.33 hrs./yr	5% of saved time productive
Indoor Navigation	Time Savings	20s, 2x/week → ~0.58 hrs./yr	5% of saved time productive
Vehicle Digital Key (Car Access)	Time Savings	80s/day, 261 days/yr → ~5.80 hrs./yr	5% of saved time productive
Vehicle Digital Key (Car Access)	Cost (Insurance)	5% reduction in insurance costs (assumes 1% of income on insurance costs)	We conservatively estimate only a 5% reduction in insurance costs
Rider Identification in Private Transport	Time Savings	20s/week → ~0.29 hrs./yr	50% use feature; 5% productivity
eID Validation in Crowded Environments	Time Savings	15s/event, 4 events/month	5% of saved time productive
V2X & Autonomous Driving	Time Savings	10s/working day → ~0.73 hrs./yr	5% of saved time productive
Driverless Valet Parking and Pickup	Time Savings	2 min/week → ~1.73 hrs./yr	50% events; 5% productivity
EV Charging	Time Savings	30s/session, 2x/week → ~0.87 hrs./yr	50% sessions enabled: 5% productivity

Use Case	Primary Benefit	Annual Saving	Conservative Estimate
Toll Collection	Time Savings	5s/day, 261 days/yr → ~0.36 hrs./yr	50% tolls enabled: 5% productivity
Open Trunk with Gesture	Time Savings	1m/day → ~6.08 hrs./yr	All users; 5% productivity
In Cabin Sensing	Time Savings	1m/trip, 2 trips per day → ~12.17 hrs./yr	All users; 5% productivity
Smart Watches	Time Savings	~24.33 hours/user/year (if all fully adopt features)	~12.17 hours/user/year (50% adoption) → ~0.61 hours/user/year (5% productivity)
UWB Smartphones	Time Savings	~18.25 hours/user/year (if all fully adopt features)	~9.13 hours/user/year (50% adoption) → ~0.46 hours/user/year (5% productivity)
Ticket Validation	Time Savings	~2.18 hours/passenger/year	~0.22 hours/passenger/year → ~0.011 hours/passenger/year
Reserved Seat Validation	Time Savings	~2 hours/passenger/year	~0.2 hours/passenger/year → ~0.01 hours/passenger/year
Ride Sharing (Precise Positioning)	Time Savings	~3.47 hours/passenger/year	~0.35 hours/passenger/year → ~0.0175 hours/passenger/year
Transportation Sharing (Bike/Scooter)	Time Savings	~5.2 hours/passenger/year	~0.52 hours/passenger/year → ~0.026 hours/passenger/year
Transportation Fare Payment	Time Savings	~2.175 hours/passenger/year	~0.2175 hours/passenger/year → ~0.0109 hours/passenger/year
Physical Access Control	Time Savings	~8.7 hours/user/year (for those checking in)	Only 5% of employees benefit; 5% of saved time is productive
Controlled Access	Time Savings	~8.33 hours/user/year (for employees requiring restricted access)	Only 5% of employees benefit; 5% productivity of saved time
Employee Gathering in Emergencies	Time Savings	Reduces verification time from ~15 min/event (for all occupants)	1 event/year; 5% productivity of saved time

Source: Telecom Advisory Services analysis

4. GENERAL STUDY RESULTS

This chapter presents the aggregated findings of the study, outlining the socio-economic contributions of UWB technology across multiple dimensions. As anticipated in the methodology, the results are presented along three primary metrics: Gross Domestic Product contribution, Producer Surplus, and Consumer Surplus, each offering unique insights into how UWB adoption impacts the global economy. These metrics are examined across key sectors, including Smart Home, Mobility, Individual Consumer, Smart Retail, Industrial, Public Transportation, and Smart Building. By integrating foundational hardware revenues, application-specific Use Case revenues, and employment impacts, the results provide a holistic perspective on the transformative potential of UWB technology.

The GDP contribution reflects the economic value generated through Chipset, TAG, and Anchor revenues as well as Use Case revenues. In parallel, the Producer Surplus highlights efficiency gains and cost reductions derived from UWB-enabled applications, particularly in sectors like Smart Retail and Industrial. These surplus captures additional productivity-driven enhancements, emphasizing operational streamlining and resource optimization. Lastly, the Consumer Surplus quantifies the direct benefits to end-users, such as time savings, reduced costs, and improved user experiences across smart homes, public transportation, and mobility solutions.

By organizing the data across these categories, the analysis provides a detailed breakdown of UWB's growing impact on global markets. Each section underscores how UWB fosters economic growth, enhances labor markets, and transforms daily activities. Through quantitative estimates, the findings highlight the strategic importance of UWB in shaping the future of connectivity, automation, and digital transformation.

4.1. UWB contribution to GDP

This section provides an analysis of UWB's contribution to GDP across seven key application areas: Smart Home, Mobility, Individual Consumer, Smart Retail, Industrial, Public Transportation and Smart Building, and their aggregated totals. The revenue estimates span from 2022 to 2030, categorized into Chipset, TAG, and Anchor revenues, Use Case revenues, and their combined totals.

The Chipset, TAG, and Anchor revenue category represents the foundational hardware that enables UWB technology adoption across various sectors. These revenues are closely tied to the growing demand for UWB-enabled devices and infrastructure. Across all seven application areas, Chipset, TAG, and Anchor revenues is expected to experience steady growth, reflecting the increasing integration of UWB technology in diverse markets such as home automation, mobility solutions, consumer devices, retail, and industrial processes (see Table 4-1).

Table 4-1. Chipset, TAG, and Anchor Revenues by Area (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR
Smart Home	$105.84	$118.15	$156.78	$236.11	$292.08	$360.19	$442.55	$531.57	$641.65	25.27%
Mobility	$19.87	$39.64	$117.46	$170.92	$239.19	$330.83	$386.53	$464.35	$535.73	50.96%
Individual consumer	$699.20	$655.93	$749.80	$935.87	$1,192.11	$1,385.98	$1,582.30	$1,754.80	$1,853.46	12.96%
Smart Retail	$38.57	$51.55	$69.61	$93.89	$119.93	$145.88	$175.44	$200.89	$223.23	24.54%
Industrial	$420.57	$483.88	$554.30	$671.49	$760.16	$859.86	$980.89	$1,119.24	$1,280.03	14.93%
TOTAL	$1,284.04	$1,349.15	$1,647.94	$2,108.29	$2,603.47	$3,082.73	$3,567.72	$4,070.85	$4,534.11	17.08%

Sources: Telecom Advisory Services analysis based on ABI Research, Techno Systems Research Co., Ltd., Organization of Motor Vehicles Manufacturers; GSMA Intelligence

The data reveals that Individual Consumer applications are the largest contributors to hardware revenue, followed by Industrial and Smart Home applications. Mobility applications also show remarkable growth, fueled by investments in connected vehicles and autonomous driving technologies. Sectors such as Public Transportation and Smart Building are expected to show significant revenue contributions as adoption accelerates in the later stages of the forecast period.

Revenues from Chipset, TAG, and Anchor sales highlight the worldwide transformative potential of UWB technology across various sectors, growing from $1,284.04 million in 2022 to $4,534.11 million in 2030. Smart Home applications, steadily increased from $105.84 million to $641.65 million over the same period, reflecting widespread residential adoption as the technology matures. Meanwhile, Mobility revenues exhibit a steep trajectory, rising from $19.87 million in 2022 to $535.73 million by 2030, driven by advancements in vehicle-to-everything (V2X) communication, navigation systems, and autonomous vehicles. The Individual Consumer sector remains the largest contributor, with revenues climbing from $699.20 million to $1,853.46 million, fueled by growing demand for UWB-enabled wearable devices and smartphones. Similarly, Industrial applications demonstrate robust growth, with revenues increasing from $420.57 million in 2022 to $1,280.03 million by 2030, driven by the technology's role in optimizing manufacturing, supply chain operations, and asset tracking. In contrast, Public Transportation and Smart Building sectors are expected to generate revenues primarily from Use Cases as UWB becomes integrated into transit systems and building management applications. Additionally, while these two areas do require hardware installation, we consider this to be included in smart home, individual consumer, and mobility. Collectively, this data underscores the increasing importance of UWB across industries, highlighting its potential to drive economic growth through continuous innovation and the growing deployment of application-specific solutions.

The Use Case revenue category captures the economic value generated by the practical deployment of UWB technology across key application areas. These revenues represent the direct contributions of UWB-enabled solutions, ranging from smart home automation and industrial tracking to mobility systems and retail innovations. While Chipset, TAG, and Anchor revenues provide the hardware backbone for UWB adoption, Use Case revenues highlight the technology's integration into daily operations and its role in enhancing productivity and efficiency. Over the forecast period, Use Case revenues are projected to grow steadily, increasing from $540.95 million in 2022 to $2,019.03 million by 2030. Key contributors to this growth include Industrial and Smart Retail sectors, which consistently demonstrate robust revenue gains driven by advancements in automation and customer engagement solutions. Public Transportation and Smart Building sectors are expected to see meaningful revenue growth in the later stages, reflecting the gradual adoption of UWB in transit systems and building management applications. These trends underline the transformative potential of UWB in creating value across diverse industries (see Table 4-2).

Table 4-2. Uses Cases Revenues by Area (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR
Smart Home	$60.01	$63.80	$80.26	$113.74	$141.59	$170.24	$203.14	$237.00	$274.25	20.92%
Mobility	$55.91	$64.75	$111.29	$153.97	$210.90	$279.77	$328.64	$390.12	$443.07	29.53%
Individual consumer	$26.26	$25.29	$30.50	$38.11	$47.86	$54.59	$61.43	$67.73	$71.60	13.36%
Smart Retail	$107.69	$131.45	$161.53	$197.37	$237.61	$277.76	$323.15	$366.90	$411.02	18.22%
Industrial	$135.84	$151.84	$170.77	$216.21	$241.51	$273.13	$312.84	$359.97	$414.65	14.97%
Public transportation	$97.03	$89.56	$98.84	$123.29	$158.55	$186.69	$215.12	$239.44	$252.77	12.71%
Smart Building	$58.22	$53.74	$59.31	$73.97	$95.13	$112.01	$129.07	$143.67	$151.66	12.71%
TOTAL	$540.95	$580.43	$712.51	$916.66	$1,133.15	$1,354.20	$1,573.39	$1,804.83	$2,019.03	17.90%

Source: Telecom Advisory Services analysis

The data in Table 4-2 illustrates the steady growth of Use Case revenues across all application areas, reflecting the increasing integration of UWB-enabled solutions into various areas. Smart Home applications show consistent growth, rising from $60.01 million in 2022 to $274.25 million in 2030, driven by demand for home automation systems. Mobility revenues demonstrate a remarkable trajectory, expanding from $55.91 million in 2022 to $443.07 million in 2030, supported by advancements in vehicle-to-everything communication, autonomous driving, and navigation systems. The Individual Consumer sector contributes steadily, with revenues growing from $26.26 million in 2022 to $71.60 million in 2030, fueled by the integration of UWB in personal devices such as wearables and smartphones.

In the Smart Retail sector, revenues grow significantly from $107.69 million in 2022 to $411.02 million in 2030, reflecting the adoption of UWB for automated checkout, inventory tracking, and customer behavior analytics. Similarly, Industrial applications see robust growth, with revenues increasing from $135.84 million in 2022 to $414.65 million by 2030, highlighting UWB's role in optimizing factory automation. Public Transportation revenues start at $97.03 million in 2022 and rise to $252.77 million by 2030, driven by the integration of UWB in ticketing systems, and passenger services. Finally, Smart Building applications show steady adoption, with revenues growing from $58.22 million in 2022 to $151.66 million in 2030, as UWB becomes integral to building management. These figures underscore the growing economic impact of UWB technology across diverse application areas.

The Total Revenue category combines both Chipset, TAG, and Anchor revenues and Use Case revenues to provide a comprehensive view of UWB's economic contribution across seven key application areas. This aggregated data highlights the sustained growth of UWB technology, which integrates foundational hardware with application-specific solutions to drive innovation and productivity. Over the forecast period, total revenues are projected to increase significantly, rising from $1,824.99 million in 2022 to $6,553.14 million by 2030. Key sectors such as Individual Consumer, Industrial, and Smart Home dominate the total revenue share, reflecting the widespread adoption of UWB in these areas. Mobility applications also show exceptional growth, supported by advancements in V2X communication and autonomous technologies. Sectors like Public Transportation and Smart Building are expected to contribute increasingly in later years as UWB adoption accelerates in these domains. This combined revenue view underscores the transformative potential of UWB technology in driving economic growth across industries (see Table 4-3).

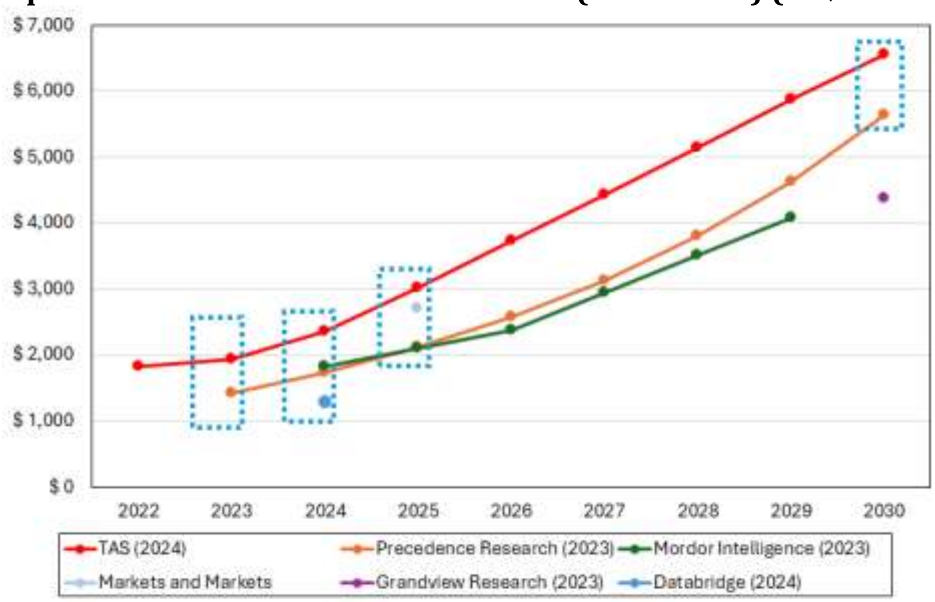
Table 4-3. Total Revenues by Area (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR
Smart Home	$165.85	$181.95	$237.04	$349.85	$433.67	$530.43	$645.69	$768.57	$915.90	23.81%
Mobility	$75.78	$104.40	$228.75	$324.89	$450.09	$610.59	$715.18	$854.47	$978.80	37.69%
Individual consumer	$725.45	$681.22	$780.30	$973.98	$1,239.97	$1,440.56	$1,643.73	$1,822.53	$1,925.06	12.97%
Smart Retail	$146.26	$183.00	$231.14	$291.26	$357.53	$423.64	$498.59	$567.79	$634.25	20.13%
Industrial	$556.41	$635.72	$725.07	$887.70	$1,001.67	$1,132.99	$1,293.73	$1,479.21	$1,694.68	14.94%
Public transportation	$97.03	$89.56	$98.84	$123.29	$158.55	$186.69	$215.12	$239.44	$252.77	12.71%
Smart Building	$58.22	$53.74	$59.31	$73.97	$95.13	$112.01	$129.07	$143.67	$151.66	12.71%
TOTAL	$1,824.99	$1,929.58	$2,360.45	$3,024.95	$3,736.62	$4,436.93	$5,141.11	$5,875.68	$6,553.14	17.33%

Source: Telecom Advisory Services analysis.

Finally, the following analysis compares revenue projections of our study presented above with previous estimates provided by other consultancies, including Precedence Research, Mordor Intelligence, Markets and Markets, Grandview Research, and Databridge. Telecom Advisory Services revenue projections stand out as higher across the forecast period, reflecting the inclusion of more recent market developments and a broader range of UWB use cases. (see Graphic 4-1).

Graphic 4-1. Global Total UWB Revenues (2022-2030) (US$ Millions)



Source: Telecom Advisory Services analysis.

Unlike earlier projections, which were constrained by narrower assumptions, Telecom Advisory Services incorporates expanded applications in sectors like Smart Retail, Industrial

Automation, and Mobility, providing a more comprehensive view of UWB's economic potential. This broader scope, combined with insights from updated market dynamics, positions our forecast as a more robust and forward-looking assessment of UWB's economic trajectory. That being said, growth vectors of the studies that present forecast of UBW revenues over time (Precedence Research and Mordor Intelligence) are relatively consistent with that of Telecom Advisory Services.

In sum, the analysis presented in this section underscores the substantial and growing economic impact of UWB technology across diverse application areas. By combining Chipset, TAG, and Anchor revenues with Use Case revenues, a comprehensive view of UWB's role in driving innovation and economic growth emerges. The data demonstrates significant revenue expansion across key sectors such as Individual Consumer, Industrial, Smart Home, and Mobility, driven by advancements in connectivity, automation, and consumer engagement. While Public Transportation and Smart Building sectors currently show smaller contributions, their projected growth highlights the potential of UWB to revolutionize transit systems and building management in the coming years. Together, these trends reinforce the transformative potential of UWB technology, emphasizing its critical role in fostering innovation, efficiency, and sustained economic development.

4.2. Employment impact

The integration of UWB technology across various industries is projected to result in significant global job creation, with employment opportunities steadily increasing over the 2022–2030 period.

By relying on input-output analysis (Katz, 2012), this study estimates the total number of jobs-years created through development and manufacturing UWB-related technologies between 2022 and 2030, categorizing them into Direct, Indirect, and Induced Jobs. Direct jobs account for the technical personnel required to manufacture, develop, and distribute UWB hardware and software, while indirect jobs emerge from upstream supply chain activities supporting these efforts. Induced jobs are created through household spending driven by income generated from direct and indirect employment (see Table 4-4).

Table 4-4. Global UWB jobs created (2022-2030) (Jobs-Year)

Category	Definition	Amount
Direct jobs	Technical staff and manufacturers of the required equipment and software to develop, distribute and serve the hardware and required used cases	159,670
Indirect Jobs	Upstream buying and selling of inputs required to develop and manufacture equipment and software	90,677
Induced Jobs	Household spending based on the income generated from the direct and indirect jobs creates induced employment	37,450
Total		287,800

Note: A job-year refers to one full-time job held for a single year, as derived from input-output analysis. Each additional unit of output generated by UWB adoption translates into incremental labor demand, which, when aggregated, is expressed in job-years.
Source: Telecom Advisory Services analysis based on input/output matrices of specific countries under study.

Direct jobs, totaling 159,700, represent the largest share of employment created through UWB adoption. These jobs are generated by the need for specialized technical staff, software developers, and manufacturers responsible for producing and maintaining UWB hardware and implementing related use cases. This includes activities such as developing UWB chipsets, manufacturing anchors and tags, and integrating UWB solutions into devices and infrastructure. The direct employment impact highlights the growing demand for skilled labor in telecommunications and high-tech industries as UWB becomes a foundational technology across diverse sectors.

Indirect jobs account for 90,600 positions, created through supply chain activities required to support the development and deployment of UWB technology. These include upstream activities such as sourcing raw materials, producing components, and providing ancillary services that facilitate UWB hardware and software manufacturing. Indirect employment reflects the extensive network of businesses and suppliers that contribute to the UWB ecosystem, emphasizing the ripple effects of UWB adoption across related industries.

Induced jobs, totaling 37,500, arise from the increased household spending enabled by household income generated through direct and indirect employment. Workers employed in UWB-related industries contribute to the broader economy by spending their earnings on goods and services, creating additional demand and subsequent employment in sectors such as retail, healthcare, and hospitality. This category underscores the broader economic impact of UWB-related job creation, extending beyond the immediate telecommunications and technology sectors.

In total, UWB-related activities are projected to generate 287,800 jobs-year globally between 2022 and 2030. This employment impact highlights the transformative potential of UWB technology not only as a driver of innovation and productivity but also as a significant contributor to economic growth and labor market development. By fostering job creation across direct, indirect, and induced categories, UWB demonstrates its capacity to support widespread socio-economic benefits, particularly in regions that embrace its adoption.

The total number of jobs-year generated globally is expected to grow from 13,409 in 2022 to 60,091 by 2030, culminating in 287,800 job-years over the entire forecast period (see Table 4-5).

Table 4-5. Global: Number of jobs-year created (2022-2030)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
Direct	7,439	8,032	9,908	12,991	16,384	19,960	23,849	27,770	33,338	159,670
Indirect	4,225	4,561	5,627	7,378	9,305	11,335	13,544	15,770	18,933	90,677
Induced	1,745	1,884	2,324	3,047	3,843	4,681	5,594	6,513	7,819	37,450
TOTAL	13,409	14,477	17,858	23,416	29,533	35,976	42,986	50,054	60,091	287,800

Note: A job-year refers to one full-time job held for a single year, as derived from input-output analysis. Each additional unit of output generated by UWB adoption translates into incremental labor demand, which, when aggregated, is expressed in job-years.

Source: Telecom Advisory Services based on input/output matrices for specific countries under analysis.

The detailed breakdown of job creation by country will be provided in Chapter 6.

4.3. Producer surplus

The Producer Surplus measured in this study represents the aggregate monetary value generated by productivity enhancements driven by UWB technology. This surplus arises from cost reductions, time savings, and operational efficiencies across key sectors, with a particular emphasis on Smart Retail and Industrial applications. Unlike the classical producer surplus embedded within GDP, the figures presented here reflect additional gains derived from improved processes and resource optimization, showcasing how UWB adoption contributes to economic growth beyond traditional metrics (see Table 4-6).

Table 4-6. Producer Surplus by Area (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR
Smart Retail	$1,090.09	$1,445.18	$1,836.46	$2,380.60	$3,138.80	$4,071.75	$5,094.82	$6,176.29	$7,248.58	26.72%
Industrial	$788.45	$1,324.72	$1,740.64	$2,365.96	$3,215.29	$4,111.37	$5,206.28	$6,505.43	$8,010.06	33.62%
TOTAL	$1,878.53	$2,769.90	$3,577.11	$4,746.56	$6,354.09	$8,183.12	$10,301.10	$12,681.72	$15,258.64	29.93%

Source: Telecom Advisory Services analysis.

In the Smart Retail sector, UWB-enabled applications drive significant productivity gains by streamlining operations such as automated checkout, inventory management, and customer behavior analytics. These enhancements translate into time savings and cost reductions that directly benefit retailers, allowing for smoother workflows and improved customer experiences. In 2022, the producer surplus in Smart Retail was valued at $1,090.09 million, increasing steadily to $7,248.58 million by 2030. This rapid growth reflects the sector's strong adoption of UWB solutions and the ongoing integration of advanced retail technologies.

The Industrial sector similarly benefits from UWB technology through applications in supply chain optimization, real-time location systems, and factory automation. These innovations lead to reduced operational inefficiencies, enhanced safety protocols, and better resource allocation. The producer surplus for Industrial applications begins at $788.45 million in 2022 and surges to $8,010.06 million by 2030. This dramatic increase underscores the transformative role of UWB in reshaping manufacturing and industrial processes.

When combined, the total producer surplus from Smart Retail and Industrial applications demonstrates consistent growth throughout the forecast period. Starting at $1,878.53 million in 2022, the surplus reaches $15,258.64 million by 2030. This cumulative impact highlights the substantial economic benefits UWB technology delivers across these two critical sectors.

The robust growth in producer surplus is driven by several factors. In Smart Retail, UWB improves operational accuracy and customer satisfaction through precise tracking and streamlined payment systems. Meanwhile, in Industrial applications, UWB enhances resource utilization and minimizes downtime by enabling real-time monitoring and automation. These innovations underscore UWB's capacity to deliver tangible cost savings and efficiency improvements.

The findings indicate that UWB technology acts as a catalyst for innovation in Smart Retail and Industrial settings. Its ability to enhance operational workflows and reduce costs encourages businesses to invest further in UWB solutions, creating a feedback loop that accelerates technological adoption and economic growth. These effects reverberate across supply chains and adjacent industries, amplifying the broader economic impact of UWB.

In conclusion, the growth of producer surplus in Smart Retail and Industrial applications highlights the transformative potential of UWB technology in driving economic efficiency and innovation. The sustained increase in surplus from 2022 to 2030 demonstrates UWB's capacity to reshape workflows, reduce costs, and unlock new economic value. As adoption continues to expand, UWB is positioned to deliver even greater contributions to productivity and economic growth across these critical sectors.

4.4. Consumer surplus

As described in the study methodology presented in chapter 3, consumer surplus represents the value consumers derive from UWB-enabled solutions beyond what they pay for the technology. This surplus reflects tangible benefits such as time saved, cost reductions, and enhanced convenience across various application areas, including Smart Home, Mobility, Individual Consumer, Public Transportation, and Smart Building. The analysis spans from 2022 to 2030 and highlights both direct financial savings and intangible benefits, such as reduced frustration and improved user experiences, emphasizing UWB's transformative potential (see Table 4-7).

Table 4-7. Consumer Surplus by Area (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030
Smart Home	$550.89	$956.13	$1,208.06	$1,643.40	$2,234.00	$2,808.98	$3,405.46	$4,076.13	$4,864.27
Mobility	$98.76	$184.49	$206.61	$307.70	$468.68	$706.34	$1,043.31	$1,425.15	$1,845.47
Individual consumer	$1,829.78	$2,149.07	$2,324.88	$2,768.06	$3,437.32	$4,280.42	$5,005.77	$5,613.81	$6,107.60
Public transportation	$328.13	$385.05	$413.15	$465.14	$570.16	$716.39	$861.02	$986.07	$1,086.30
Smart Building	$307.08	$366.55	$401.64	$442.84	$535.04	$668.09	$810.96	$937.50	$1,040.60
TOTAL	$3,114.64	$4,041.30	$4,554.33	$5,627.14	$7,245.21	$9,180.22	$11,126.52	$13,038.66	$14,944.24

Source: Telecom Advisory Services analysis.

The Smart Home sector delivers the second largest consumer surplus among all application areas, beginning at $550.89 million in 2022 and rising steadily to $4,864.27 million in 2030. This growth is driven by the widespread adoption of UWB-enabled devices for home automation, including connected appliances, security systems, and energy-efficient solutions. By saving time and reducing energy costs, these applications significantly enhance the convenience and affordability of managing home environments. The rapid increase in surplus reflects the growing penetration of UWB technology in residential settings and its ability to deliver high-value benefits to consumers.

In the Mobility sector, UWB applications such as vehicle-to-everything communication, autonomous driving, and precise navigation contribute to a growing consumer surplus. Starting at $98.76 million in 2022, this surplus expands to $1,845.47 million by 2030, showcasing the increasing adoption of UWB in mobility solutions. These applications reduce commuting times, enhance travel safety, and streamline in-vehicle experiences, offering both financial and experiential value to users. The mobility sector's surplus growth accelerates in the latter years of the forecast period as UWB becomes a standard feature in automotive systems and public transit applications.

The Individual Consumer segment consistently generates the highest surplus, reflecting the widespread use of UWB in personal devices such as smartphones and wearables accessories. Beginning at $1,829.78 million in 2022, this surplus grows to $6,107.60 million by 2030, driven by time savings, enhanced connectivity, and improved device interoperability. The increasing affordability and utility of UWB-enabled devices further amplify the surplus, making this segment the cornerstone of UWB's consumer impact.

In Public Transportation, UWB contributes to consumer surplus through applications like real-time ticketing and precise passenger tracking. Starting at $328.13 million in 2022, the surplus rises to $1,086.30 million by 2030. These solutions save passengers time by reducing delays, improving route efficiency, and offering seamless access to transit services. As adoption accelerates, particularly in urban areas, the surplus underscores UWB’s role in enhancing the convenience and efficiency of public transit systems.

The Smart Building sector generates a growing consumer surplus over the forecast period. Beginning at $307.08 million in 2022, this surplus increases to $1,040.60 million by 2030. The surplus reflects the increasing integration of UWB technology into smart building ecosystems, providing both financial and experiential benefits to occupants.

Across all sectors, the total consumer surplus grows from $3,114.64 million in 2022 to $14,944.24 million in 2030, highlighting the transformative impact of UWB technology on consumer experiences. This growth is driven by time savings, cost reductions, and improved convenience, with the largest contributions coming from the Individual Consumer and Smart Home segments. The findings emphasize UWB’s potential to enhance quality of life across diverse application areas, reinforcing its value as a critical driver of economic and societal benefit.

4.5. Total impact

UWB’s overall economic contribution can be comprehensively understood by examining the three key metrics explored in previous sections: Gross Domestic Product contribution, Producer Surplus, and Consumer Surplus. Although each of these measures captures a distinct aspect of value creation, their combined results offer a holistic perspective on the technology’s total impact. As shown in the accompanying analysis, GDP figures shed light on the revenue generated through hardware components and integrated use-case deployments, Producer Surplus highlights operational efficiencies for businesses, and Consumer Surplus quantifies the benefits that end-users accrue in daily routines.

From a purely economic standpoint, GDP captures the revenue streams flowing into the market for UWB-enabled products and services, reflecting the sector's expanding role in global output. In 2022, UWB adoption contributed an estimated US$1,824.99 million to world GDP, a figure projected to rise to US$6,553.14 million by 2030. These numbers, spanning both hardware (Chipset, TAG, Anchor) and complementary software solutions, underline how UWB enriches diverse industries thereby expanding the overall volume of economic activity.

Producer Surplus, by contrast, signifies the monetary gains that enterprises retain once they factor in cost reductions and efficiencies derived from UWB technology. Beginning at US$1,878.53 million in 2022, this surplus is projected to grow sharply to US$15,258.64 million by 2030, driven mainly by widespread automation in smart retail, industrial optimization through precise asset tracking, and other business-focused applications. Such upward momentum reveals how UWB helps reduce operational overhead, accelerate workflows, and enhance supply chain reliability, all culminating in enhanced profitability for firms.

On the consumer side, UWB consistently shows strong potential to improve convenience, save time, and augment everyday interactions. From contactless transit fare payments to real-time localization within public spaces, these user-level innovations translate into meaningful Consumer Surplus, estimated at US$3,114.64 million in 2022 and forecast to surpass US$14,944.24 million by 2030. This growth reflects the rising adoption of UWB-enabled smartphones, wearable devices, and smart home solutions that simplify tasks while reducing friction in day-to-day life.

Although GDP, Producer Surplus, and Consumer Surplus each illustrates a unique dimension of UWB's value, combining them underscores the magnitude of the technology's global footprint. When these measures are added together, the total impact for 2022 reaches US$6,818.17 million, expanding to US$36,756.02 million by 2030. This aggregated figure highlights UWB's ability not just to boost output and corporate efficiency, but also to enhance consumer welfare—factors that, when viewed collectively, confirm the multifaceted and far-reaching impact of UWB deployment (see Table 4-8)

Table 4-8. Global Total Economic Impact (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR
Gross Domestic Product	$1,824.99	$1,929.58	$2,360.45	$3,024.95	$3,736.62	$4,436.93	$5,141.11	$5,875.68	$6,553.14	17.33%
Producer Surplus	$1,878.53	$2,769.90	$3,577.11	$4,746.56	$6,354.09	$8,183.12	$10,301.10	$12,681.72	$15,258.64	29.93%
Consumer Surplus	$3,114.64	$4,041.30	$4,554.33	$5,627.14	$7,245.21	$ 9,180.22	$11,126.52	$13,038.66	$14,944.24	21.66%
TOTAL	$6,818.17	$8,740.78	$10,491.89	$13,398.65	$17,335.92	$21,800.27	$26,568.73	$31,596.06	$36,756.02	23.44%

Source: Telecom Advisory Services analysis.

Moving forward, these interlinked metrics—GDP growth, Producer Surplus, and Consumer Surplus—will likely intensify as more regions refine their spectrum policies, reduce cost barriers for device manufacturers, and foster consumer familiarity with UWB's tangible benefits. By addressing both the supply and demand sides of the market, stakeholders ensure that the economic gains of UWB extend well beyond core industries, promoting job creation, supporting safety and welfare improvements, and accelerating digital transformation across multiple areas of the global economy.

5. INTERPRETATION OF STUDY RESULTS

This chapter presents a comprehensive interpretation of the study's findings, contextualizing the economic and societal contributions of UWB technology across key metrics: GDP contribution, employment, producer surplus, and consumer surplus. By examining the results through a critical lens this chapter highlights the dynamics driving UWB's transformative impact on global markets and labor markets. The analysis situates UWB within the broader digital transformation landscape, illustrating its potential to enhance productivity, foster innovation, and elevate consumer experiences.

The chapter is structured into two sections. The first section, Interpretation of Key Results, explores the magnitude and distribution of UWB's economic contributions, providing an understanding of its role in driving GDP growth, job creation, and welfare enhancements. The second section, Comparisons with Related Technologies, positions UWB alongside alternative connectivity solutions, such as Wi - Fi, to underscore its unique economic advantages. Together, these insights provide a robust framework for understanding UWB's transformative potential and its implications for policymakers, industries, and consumers.

5.1. Interpretation of Key Results

The results of this study underscore the transformative economic and societal impacts of UWB technology across diverse application areas and regions. With an annual contribution to global GDP projected to exceed USD 6.55 billion by 2030, UWB demonstrates its potential to drive sustained economic growth. This increase is fueled by widespread adoption in sectors such as Smart Home, Mobility, and Industrial applications. The results highlight how UWB has matured into a critical enabler of innovation, creating significant value for producers, consumers, and the broader economy (see Table 5-1).

Table 5-1. Global Economic Impact (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR
Gross Domestic Product	$1,824.99	$1,929.58	$2,360.45	$3,024.95	$3,736.62	$4,436.93	$5,141.11	$5,875.68	$6,553.14	17.33%
Producer Surplus	$1,878.53	$2,769.90	$3,577.11	$4,746.56	$6,354.09	$8,183.12	$10,301.10	$12,681.72	$15,258.64	29.93%
Consumer Surplus	$3,114.64	$4,041.30	$4,554.33	$5,627.14	$7,245.21	$ 9,180.22	$11,126.52	$13,038.66	$14,944.24	21.66%
TOTAL	$6,818.17	$8,740.78	$10,491.89	$13,398.65	$17,335.92	$21,800.27	$26,568.73	$31,596.06	$36,756.02	23.44%

Source: Telecom Advisory Services analysis.

One of the most compelling insights is UWB's capacity to generate substantial producer surplus, estimated at over USD 15.26 billion by 2030. This reflects significant productivity enhancements across sectors like Smart Retail and Industrial applications, where UWB-driven solutions streamline operations, optimize workflows, and reduce costs. These efficiency gains underscore the importance of continued investment in UWB to foster greater industrial competitiveness and economic resilience.

Consumer surplus, projected to grow to USD 14.94 billion by 2030, illustrates the significant benefits UWB delivers to end-users. These include tangible time savings, cost reductions, and enhanced convenience, spanning applications such as smart home automation, seamless mobility solutions, and enhanced public transportation systems. The Individual Consumer and Smart Home segments dominate this surplus, reflecting the widespread use of UWB-enabled devices in personal and residential contexts.

The global employment impact of UWB technology further highlights its socio-economic value. Between 2022 and 2030, UWB adoption is expected to generate over 287,800 job-years, with consistent growth across direct, indirect, and induced employment categories. These figures underscore UWB's ability to stimulate labor markets by creating demand for technical roles, supporting supply chains, and generating income-driven household spending.

Regional variations in UWB's economic impact, to be presented in detail in chapter 6, reveal significant disparities in adoption and contribution. Advanced economies like the United States and China exhibit the largest GDP contributions and employment effects, reflecting their early and comprehensive adoption of UWB solutions. Conversely, emerging markets in regions such as Africa and Latin America demonstrate slower but steady growth, highlighting the need for supportive regulatory frameworks and infrastructure development to accelerate adoption.

The study also highlights the sector-specific impacts of UWB, with Individual Consumer applications leading in economic contributions, followed by Industrial and Smart Retail sectors. This distribution reflects the dual role of UWB in enhancing individual convenience while driving operational efficiencies at scale. Mobility applications, while currently contributing less to GDP, demonstrate the fastest growth trajectory, driven by advancements in vehicle-to-everything communication and autonomous driving.

The integration of UWB into Public Transportation and Smart Building applications lags behind other sectors but shows strong potential for future growth. As adoption accelerates in these areas, UWB is expected to revolutionize transit systems, building management, and urban infrastructure, further amplifying its economic and social value in the later stages of the forecast period.

In conclusion, the study presents a compelling case for UWB as a transformative technology that drives economic growth, enhances productivity, and improves consumer experiences across diverse sectors. By 2030, the combined economic impact of UWB—including contributions to Gross Domestic Product, producer surplus, and consumer surplus—is projected to reach a total of $36.76 billion. As adoption accelerates globally, UWB's potential to deliver widespread socio-economic benefits will likely increase, provided that supportive regulatory, technical, and market conditions are maintained.

5.2. Comparisons with Related Technologies

Drawing upon the study's overarching methodological approach, this section positions UWB alongside alternative wireless connectivity solutions to gauge whether these newer, more precise technologies offer unique economic advantages or simply replicate existing value drivers. The discussion draws parallels with Wi-Fi, a ubiquitous platform that has undergone extensive adoption worldwide, generating substantial economic benefits in the process—yet showing notable divergences in how it scales and interacts with end-users. (See Table 5-2)

Table 5-2. Global Economic Impact (2025)

Area	UWB (US$ Millions)	Wi-Fi (US$ Billions)
Gross Domestic Product	$3,024.95	$789.33
Producer Surplus	$4,746.56	$1,919.98
Consumer Surplus	$5,627.14	$2,120.14
TOTAL	$13,398.65	$4,829.45
Jobs-Year	23,416	3,932,266

Sources: Telecom Advisory Services (2021). The Economic value of Wi-Fi: A Global View (2021-2025), November 2020; Telecom Advisory Services analysis.

In comparing the aggregated global economic impact of UWB to that of Wi-Fi, it becomes apparent that Wi-Fi, as a far more established and widely deployed technology, commands significantly higher GDP, producer surplus, and consumer surplus figures. Still, even at a relatively nascent stage, UWB exhibits a notable potential for value creation—particularly in specialized use cases such as secure proximity authentication and high-precision sensing—suggesting that its unique technical attributes could sustain long-term economic growth. This disparity in aggregate impact is also reflected in job creation, with Wi-Fi already generating millions of employment opportunities, whereas UWB remains on a comparatively smaller scale.

The substantial gap in impact between these two wireless technologies underscores UWB's recent market entry and comparatively limited diffusion. Where Wi-Fi's decades-long presence has facilitated near-ubiquitous device integration, UWB is still progressing through its initial phase of standardization and application development. As industry stakeholders further refine UWB chipsets, optimize integration frameworks, and cultivate targeted use cases—from high-security payments to robust device-free localization—the technology's economic footprint is projected to expand. Consequently, while Wi-Fi's legacy position ensures its continued macroeconomic prominence, emerging solutions like UWB—backed by niche capabilities and growing demand for precision—stand poised to deliver incremental, and potentially transformative, global benefits in the near future.

Building on this global comparison, it is useful to zoom in on a single market to understand how these contrasting patterns of impact play out within a more localized context. The United States, representing one of the most dynamic and competitive arenas for wireless technology deployment, offers revealing insights into how UWB and Wi-Fi currently stack up across GDP contribution, producer surplus, consumer surplus, and overall economic value (See Table 5-3)

Table 5-3. UWB – United States Economic Impact (2023-2027) (US$ Millions for UWB and US$ Billion for Wi-Fi)

Area	2023		2024		2025		2026		2027	
	UWB	Wi-Fi	UWB	Wi-Fi	UWB	Wi-Fi	UWB	Wi-Fi	UWB	Wi-Fi
Gross Domestic Product	$470	$592	$560	$769	$658	$935	$746	$1,078	$810	$1,286
Producer Surplus	$1,005	$382	$1,247	$441	$1,609	$510	$2,081	$570	$3,220	$624
Consumer Surplus	$2,125	$339	$2,360	$392	$2,832	$444	$3,362	$483	$4,231	$514
TOTAL	$3,600	$1,314	$4,166	$1,602	$5,099	$1,889	$6,189	$2,131	$8,321	$2,424

Sources: Telecom Advisory Services (2024). "An assessment of Wi-Fi economic value in the United States", September 2024. New York; Telecom Advisory Services analysis

A closer look at these U.S. figures reinforces the broader conclusion that Wi-Fi remains ahead in aggregate economic impact, largely a result of its extensive deployment base and seamless integration into consumer and enterprise markets. With decades of market acceptance, Wi-Fi networks have become deeply entrenched across retail, public services, and private homes—creating pervasive user reliance and an expansive application ecosystem. In contrast, UWB's presence, although visibly growing, is still nascent and concentrated in specialized, high-security or high-precision use cases like digital key applications, indoor positioning, or secure payment systems.

Between 2023 and 2027, UWB's GDP contribution in the United States grows from USD 470 million to USD 810 million, representing a 72% increase over that span, while Wi-Fi's GDP contribution rises from USD 592 billion to USD 1.286 billion, a 117% increase. By contrast, the Producer Surplus for UWB expands much more steeply jumping 220% (from USD 1.005 million to USD 3.220 million), compared to a 63% gain for Wi-Fi (from USD 382 billion to USD 624 billion). Looking at Consumer Surplus, UWB's growth nearly doubles, climbing 99% (from USD 2.125 million to USD 4.231 million), while Wi-Fi increases by 52% (from USD 339 billion to USD 514 billion). Consequently, when summing up all three dimensions, UWB's Total Economic Impact more than doubles—rising 131% (from USD 3.600 million to USD 8.321 million), whereas Wi-Fi's total impact grows by 85% (from USD 1.314 billion to USD 2.424 billion). These comparisons show that even though Wi-Fi still holds a larger overall footprint in some categories, UWB demonstrates a faster relative growth rate—particularly in producer and consumer surplus—pointing to its expanding economic significance in the coming years.

So, the data illustrate that UWB demonstrates a noteworthy trajectory of value growth year over year. While it lags behind Wi-Fi in present impact, its specific advantages in precision, security, and low-latency communication make it a strong candidate for deeper market penetration in emerging sectors. As chipset costs decrease, standardization efforts progress, and industry verticals increasingly adopt UWB-enabled solutions, the technology's footprint in the United States is poised to expand considerably—potentially closing some of the current economic gap with Wi-Fi over the coming years.

6. ULTRAWIDEBAND ECONOMIC CONTRIBUTION BY COUNTRY

In presenting the preceding analysis of overall results, it becomes necessary to understand how the socio-economic impact of UWB manifest itself at the country level. The empirical work conducted thus far indicates that UWB technologies, including precise location tracking and enhanced connectivity, benefit businesses and end-users in multiple application areas. This transnational scope underscores the importance of examining differences in adoption rates and market structures when estimating UWB's aggregate value in distinct national contexts.

Examining UWB's country-specific contribution also highlights how various economic conditions interact with technological diffusion. In some regions, established digital infrastructure and robust collaboration among industry stakeholders create a fertile environment for rapid UWB uptake, whereas in others, infrastructural gaps can temper the pace of implementation. Nonetheless, as detailed in the following subsections, the broader trend—recurrent across diverse markets—is that UWB's transformative potential becomes increasingly evident once the necessary technological and economic elements align.

By synthesizing data on expected device adoption, contribution to GDP, producer and consumer surplus, and employment generation, each country-level analysis offers a granular view of UWB's real-world impact. In doing so, it demonstrates how factors such as population density and industrial composition affect projected benefits. The subsequent sections therefore serve to contextualize the global outlook on UWB by articulating the specific economic and social value this technology brings to individual nations, starting with the United States.

6.1. UWB social and economic value in the United States

Within the context of assessing UWB's global reach, the United States stands out as a prominent market where widespread adoption spans both consumer and enterprise segments. Current data indicate that UWB solutions for smart home automation, mobility enhancements, and industrial applications have gained traction more rapidly here than in any other nation, largely due to sustained investment in digital infrastructure. Moreover, the country's extensive tech-driven ecosystem has fostered robust innovation, with numerous startups and established firms actively expanding UWB use cases. This dynamic setting, combined with substantial consumer demand for next-generation connectivity solutions, has propelled the United States to the forefront of global UWB adoption (see Table 6-1).

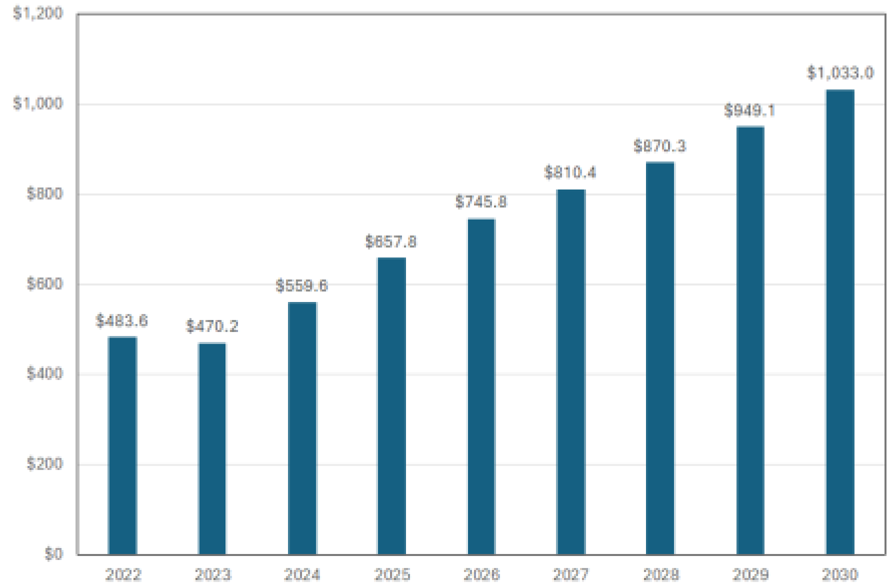
Table 6-1. United States: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	99.75	30.82%	144.21	14.18%
	Residential access control	2.31	30.82%	7.37	14.18%
	Easy (logistical) access to personal devices	0.15	30.82%	0.85	14.18%
	All gaming	2.18	30.82%	7.17	14.18%
	Audio streaming	0.00	30.82%	1.19	14.18%
	Gesture-based control	2.31	30.82%	7.37	14.18%
	VR gaming and group play	2.18	30.82%	7.17	14.18%
	Find someone/something nearby	9.64	30.82%	17.37	14.18%
	Smart speaker	4.88	30.82%	6.59	14.18%
	Presence-based device activation	0.00	30.82%	2.01	14.18%
Mobility	Parking garage access control	6.29	25.28%	36.88	25.89%
	Indoor navigation	6.29	25.28%	36.88	25.89%
	Vehicle digital key (car access)	1.28	25.28%	8.63	25.89%
	Rider identification in private transport services	85.48	30.82%	127.84	14.18%
	eID validation in crowded environments	85.48	30.82%	127.84	14.18%
	V2X and autonomous driving	6.29	25.28%	36.88	25.89%
	Driverless valet parking	6.29	25.28%	36.88	25.89%
	EV charging	1.97	25.28%	11.59	25.89%
	Toll collection	6.29	25.28%	36.88	25.89%
	Open trunk with gesture	0.19	25.28%	1.18	25.89%
	In cabin sensing	0.45	25.28%	7.75	25.89%
Individual consumer	Smart watches	14.28	30.82%	16.37	14.18%
	UWB smartphones	85.48	30.82%	127.84	14.18%
Smart retail	Tap-free mobile payment	85.48	30.82%	127.84	14.18%
	Unmanned store access	1.19	14.22%	4.19	14.27%
	Foot traffic and shopping behavior analytics	1.19	14.22%	4.19	14.27%
	Exhibition attendee management	1.19	14.22%	4.19	14.27%
	Targeted marketing	1.19	14.22%	4.19	14.27%
	Drone controlled delivery	4.45	14.22%	17.49	14.27%
	In-vehicle payment	6.29	25.28%	36.88	25.89%
Industrial	Indoor navigation	1.19	14.22%	4.19	14.27%
	Proximity-based patient data sharing	0.95	14.22%	3.91	14.27%
	Teleconference system	0.23	14.22%	2.03	14.27%
	Patient tracking	0.95	14.22%	3.91	14.27%
	Industrial real-time location systems	1.19	14.22%	4.19	14.27%
Public transportation	Ticket validation	85.48	30.82%	127.84	14.18%
	Reserved seat validation	85.48	30.82%	127.84	14.18%
	Ride sharing (precise positioning)	85.48	30.82%	127.84	14.18%
	Transportation sharing (find a bike or scooter nearby)	85.48	30.82%	127.84	14.18%
	Transportation fare payment	85.48	30.82%	127.84	14.18%
Smart building	Physical Access control	85.48	30.82%	127.84	14.18%
	Controlled access	85.48	30.82%	127.84	14.18%
	Employee gathering in emergencies	85.48	30.82%	127.84	14.18%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

UWB's contribution to the United States GDP demonstrates a steady upward trajectory, driven by ongoing advancements in device integration and widespread application across key sectors. The model's forecasts indicate that in 2024 alone, UWB will account for an estimated USD 559.6 million in additional economic output. From a broader temporal lens, the total cumulative value from 2022 to 2030 is projected to reach USD 6.58 billion, reflecting continued growth as industries such as automotive, consumer electronics, and logistics adopt UWB-enabled solutions at scale (see Graphic 6-1).

Graphic 6-1. United States: UWB contribution to GDP (2022-2030)



NOTE: Although the number of UWB-enabled units rose from 2022 to 2023, the overall revenue dipped slightly due to scalability effects. As production ramps up, the per-unit cost declines faster than the increase in units sold, resulting in a temporary decrease in total revenue.
Sources: Techno Systems Research; Telecom Advisory Services analysis

The contribution to GDP also has a direct influence on employment generation, reflecting how increases in economic output stimulate demand for labor in related industries. Between 2022 and 2030, UWB is projected to create approximately 27,600 job/years[58], as indicated by the annual breakdown of employment effects in the input/output matrix. These figures reflect not only the jobs directly associated with UWB deployment—such as manufacturing chipsets, integrating software, or installing anchor systems—but also the indirect and induced employment that arises as additional wages circulate through the broader economy. In particular, the year-by-year progression points to a gradually accelerating trend, with initial growth in 2,000 eventually surpassing 4,300 annual jobs in the latter period. This pattern underscores how early investments in UWB can yield compounding benefits over time, as more companies incorporate UWB-enabled solutions into their offerings and as consumer demand continues to expand. The table below provides a detailed illustration of these job-creation estimates from 2022 to 2030 (see Table 6-2).

[58] A job-year refers to one full-time job held for a single year, as derived from input-output analysis. Each additional unit of output generated by UWB adoption translates into incremental labor demand, which, when aggregated, is expressed in job-years.

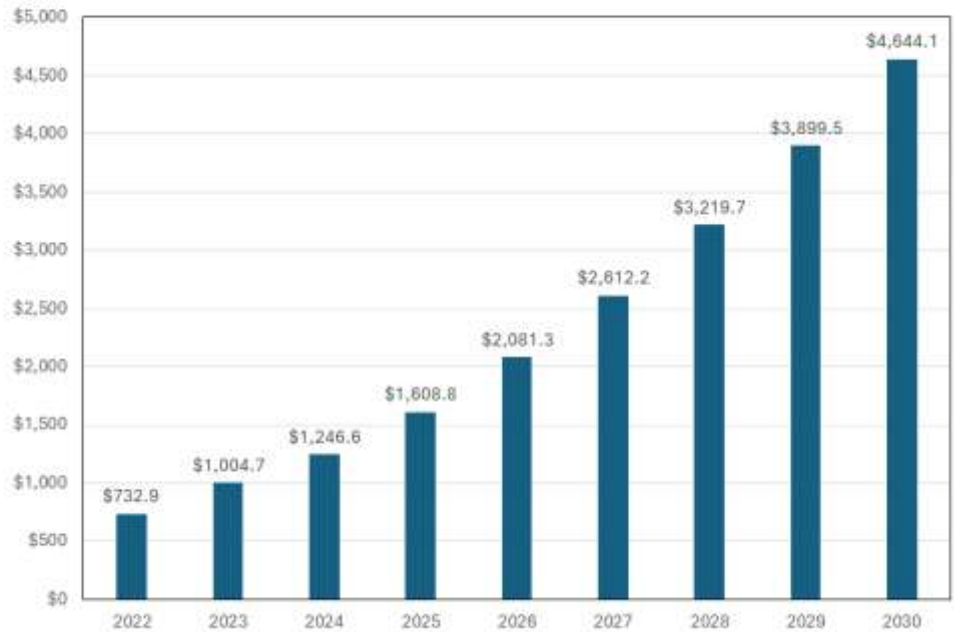
Table 6-2. United States: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
2,034	1,978	2,354	2,767	3,137	3,409	3,661	3,992	4,345	27,677

Source: Telecom Advisory Services analysis based on input/output matrix

Beyond these effects, the incremental producer surplus attributed to UWB adoption in the United States underscores the technology's capacity to drive cost efficiencies and operational improvements in multiple commercial arenas. These productivity gains amounted to USD 1.25 billion in 2024 and are expected to grow significantly over the forecast period, culminating in USD 21.05 billion between 2022 and 2030. This trajectory highlights UWB's role as a catalyst for streamlined processes and heightened competitiveness across a variety of enterprise segments, as illustrated by the annual growth pattern (see Graphic 6-2).

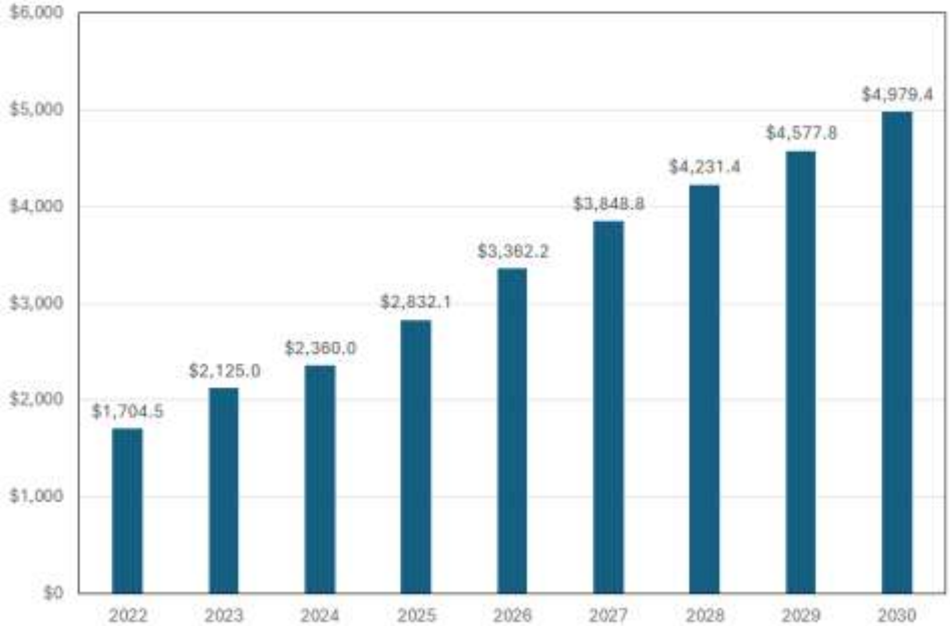
Graphic 6-2. United States: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Similarly, UWB delivers significant benefits to consumers by reducing time spent on everyday activities in both home environments and personal mobility settings. These gains are particularly evident in applications such as automated device pairing, streamlined payment systems, and improved navigation tools, each of which enhances convenience and frees users for more productive or leisure-oriented pursuits. Even under a conservative set of assumptions, this enhancement to consumer welfare in the United States is projected to reach USD 2.36 billion by 2024, reflecting both increasing user familiarity with UWB features and continued expansion of related services. Over the longer term, these consumer surplus gains are set to continue rising, as evidenced by the annual escalation shown in the following chart (see Graphic 6-3).

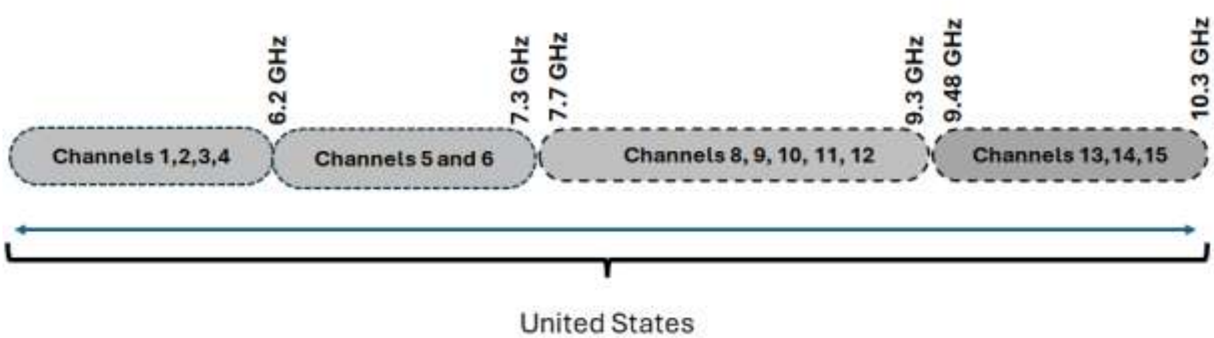
Graphic 6-3. United States: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Part of the United States' leadership in the advancement and economic influence of UWB stems from the extensive range of spectrum bands available for UWB transmission. By design, UWB devices in the United States can operate across multiple frequency segments, thereby enabling higher data throughput, more precise location accuracy, and reduced interference from other sources. Because UWB relies on spreading signals over a wide section of the frequency domain, having access to more channels allows developers and manufacturers to optimize power levels and bandwidth for each new deployment scenario (see Figure 6-1).

Figure 6-1. United States: UWB spectrum allocation



Source: Federal Communications Commission

In view of the unclear impact caused by UWB devices, the Federal Communications Commission

(FCC) adopted initially a cautious approach in devising its standards regarding UWB technology.[59] In general terms, the FCC believes that the combination of technical standards and operational restrictions will help ensuring that UWB devices can coexist and give adequate protection to other radiocommunication services.[60]

Since 2004, there has been significant change in UWB use cases. UWB initially was expected to be used for wireless communication and in wall/ground penetrating devices. However, today UWB innovations are being driven by low-power, precision location and sensing applications, which demand different regulatory limitations. Therefore, while the FCC rules have not changed, there have been a large number of FCC waiver requests, to enable the deployment of new UWB use cases and applications. Especially, in recent years, the FCC has granted many waivers to facilitate such deployments. An updated regulatory framework would lower the burden of requesting waivers and would further facilitate UWB growth.

6.2. UWB social and economic value in Canada

Canada's evolving UWB landscape demonstrates noteworthy growth across both consumer and enterprise segments, reflecting a steady increase in the deployment of devices and applications. For instance, the projected number of "point and trigger controller app" units are expected to grow from 11.25 million in 2024 to 16.53 million by 2030, illustrating a broadened adoption in smart home contexts. Similarly, "tap-free mobile payment" units are projected to rise from 9.64 million in 2024 to 14.65 million in 2030, underscoring the expanding role of UWB-enabled transactions in retail and service environments. These shifts point to a wider trend of rising penetration rates for UWB technology, indicating sustained socio-economic impact across multiple sectors over the forecast period (see Table 6-3).

Table 6-3. Canada: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	11.25	3.48%	16.53	1.62%
	Residential access control	0.26	3.48%	0.84	1.62%
	Easy (logistical) access to personal devices	0.02	3.48%	0.10	1.62%
	All gaming	0.25	3.48%	0.82	1.62%
	Audio streaming	0.00	3.48%	0.14	1.62%
	Gesture-based control	0.26	3.48%	0.84	1.62%
	VR gaming and group play	0.25	3.48%	0.82	1.62%
	Find someone/something nearby	1.09	3.48%	1.99	1.62%
	Smart speaker	0.55	3.48%	0.76	1.62%

59 FCC (2020). *Modernizing the 5.9 GHz band. Furst report and order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification*. ET Docket No. 19-138. Retrieved in: https://docs.fcc.gov/public/attachments/DOC-367827A1.pdf

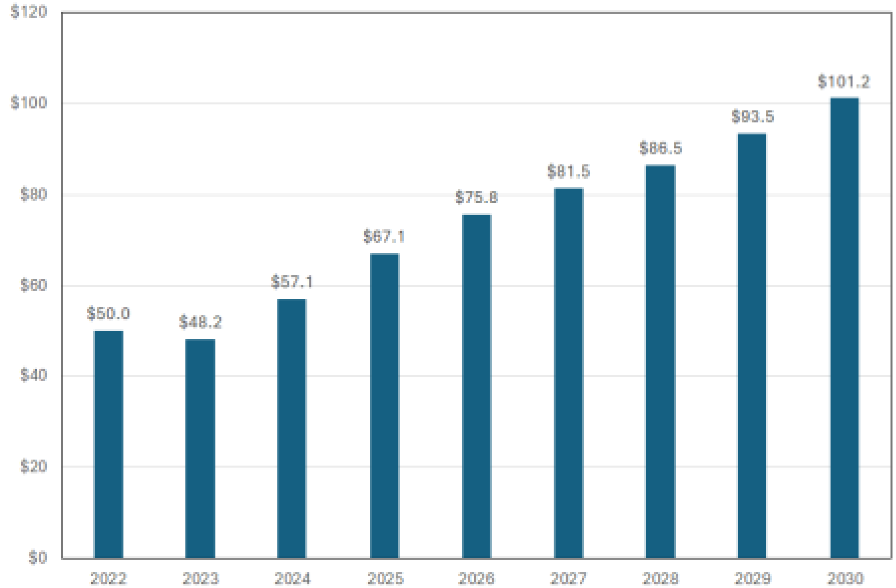
60 FCC 47 CFR 15.517 – Technical requirements for indoor UWB systems. Retrieved in: https://www.law.cornell.edu/cfr/text/47/15.517#

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Presence-based device activation	0.00	3.48%	0.23	1.62%
Mobility	Parking garage access control	0.57	2.29%	3.33	2.34%
	Indoor navigation	0.57	2.29%	3.33	2.34%
	Vehicle digital key (car access)	0.12	2.29%	0.78	2.34%
	Rider identification in private transport services	9.64	3.48%	14.65	1.62%
	eID validation in crowded environments	9.64	3.48%	14.65	1.62%
	V2X and autonomous driving	0.57	2.29%	3.33	2.34%
	Driverless valet parking	0.57	2.29%	3.33	2.34%
	EV charging	0.18	2.29%	1.05	2.34%
	Toll collection	0.57	2.29%	3.33	2.34%
	Open trunk with gesture	0.02	2.29%	0.11	2.34%
	In cabin sensing	0.04	2.29%	0.70	2.34%
Individual consumer	Smart watches	1.61	3.48%	1.88	1.62%
	UWB smartphones	9.64	3.48%	14.65	1.62%
Smart retail	Tap-free mobile payment	9.64	3.48%	14.65	1.62%
	Unmanned store access	0.09	1.08%	0.33	1.13%
	Foot traffic and shopping behavior analytics	0.09	1.08%	0.33	1.13%
	Exhibition attendee management	0.09	1.08%	0.33	1.13%
	Targeted marketing	0.09	1.08%	0.33	1.13%
	Drone controlled delivery	0.34	1.08%	1.38	1.13%
	In-vehicle payment	0.57	2.29%	3.33	2.34%
Industrial	Indoor navigation	0.09	1.08%	0.33	1.13%
	Proximity-based patient data sharing	0.07	1.08%	0.31	1.13%
	Teleconference system	0.02	1.08%	0.16	1.13%
	Patient tracking	0.07	1.08%	0.31	1.13%
	Industrial real-time location systems	0.09	1.08%	0.33	1.13%
Public transportation	Ticket validation	9.64	3.48%	14.65	1.62%
	Reserved seat validation	9.64	3.48%	14.65	1.62%
	Ride sharing (precise positioning)	9.64	3.48%	14.65	1.62%
	Transportation sharing (find a bike or scooter nearby)	9.64	3.48%	14.65	1.62%
	Transportation fare payment	9.64	3.48%	14.65	1.62%
Smart building	Physical Access control	9.64	3.48%	14.65	1.62%
	Controlled access	9.64	3.48%	14.65	1.62%
	Employee gathering in emergencies	9.64	3.48%	14.65	1.62%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

In 2024 alone, Canada's UWB contribution to GDP is projected to reach USD 57.1 million, reflecting the early-stage growth of UWB deployment across key sectors. By 2030, this figure is expected to climb further to USD 101.2 million, underscoring the ongoing maturation of UWB-driven innovations. When considering the entire 2022–2030 period, cumulative contributions are forecast to surpass USD 660.9 million, highlighting the steady impact of UWB on Canada's economic output as adoption accelerates over time (see Graphic 6-4).

Graphic 6-4. Canada: UWB contribution to GDP (2022-2030)



NOTE: Although the number of UWB-enabled units rose from 2022 to 2023, the overall revenue dipped slightly due to scalability effects. As production ramps up, the per-unit cost declines faster than the increase in units sold, resulting in a temporary decrease in total revenue.
Sources: Techno Systems Research; Telecom Advisory Services analysis

Canada's UWB ecosystem is also poised to boost employment across various technical and service-oriented functions, ranging from hardware integration to the support of new UWB-enabled applications. Over the 2022 to 2030 period, the total number of job/years generated is forecast to reach 1,544, indicating a gradual yet consistent increase that parallels the adoption of UWB solutions. As shown below, annual job creation expands from just over a hundred roles in 2022 to more than double that figure by 2030, illustrating how ongoing developments in UWB continue to stimulate labor demand in both established and emerging sectors (see Table 6-4).

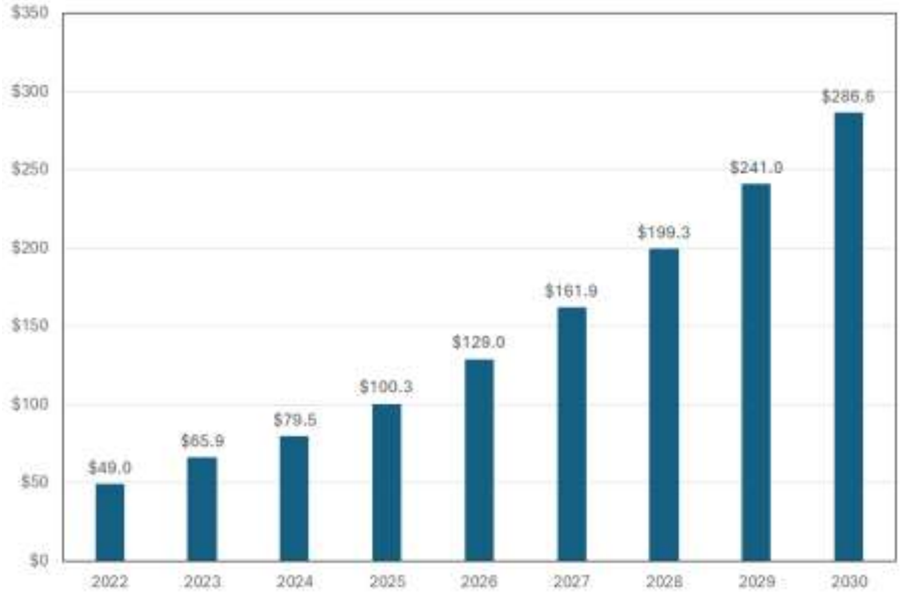
Table 6-4. Canada: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
117	113	133	157	177	190	202	219	236	1,544

Source: Telecom Advisory Services analysis based on input/output matrix

Canada's producer surplus from UWB adoption reflects the growing operational efficiencies that industries achieve as they integrate location-aware processes, automated resource allocation, and other data-driven functionalities. In 2024 alone, these productivity gains are estimated to amount to USD 79.5 million, signifying early-stage benefits as various sectors leverage UWB-enabled improvements. By 2030, the model projects that this surplus will climb to USD 286.6 million, with the cumulative total from 2022 to 2030 reaching approximately USD 1.31 billion. This upward trend reinforces the role of UWB as a catalyst for bolstering industrial competitiveness and economic performance over time (see Graphic 6-5).

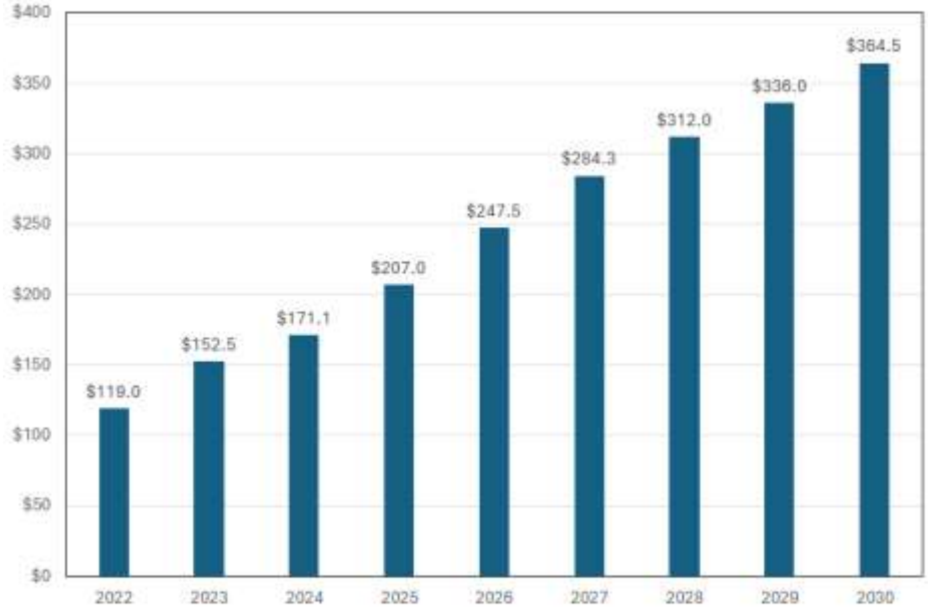
Graphic 6-5. Canada: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Canada's consumer surplus associated with UWB adoption mirrors the increasing convenience and efficiency that end-users experience. In 2024, this surplus is estimated at USD 171.1 million, marking a significant midpoint in the broader trajectory of adoption. By 2030, the consumer surplus is forecast to climb to USD 364.5 million, reflecting deeper market penetration and user familiarity with UWB-enabled features. Cumulatively, from 2022 through 2030, these consumer benefits are projected to exceed USD 2.2 billion, underscoring how everyday efficiencies can deliver substantial long-term value to Canadians (see Graphic 6-6).

Graphic 6-6. Canada: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

UWB technology operates across a wide spectrum of frequencies and is regulated to ensure efficient and interference-free usage. In Canada, the management of the UWB spectrum falls under the purview of Innovation, Science and Economic Development Canada (ISED). UWB devices are subject to the Radio Standards Specification (RSS-220), which outlines the technical and operational requirements to minimize interference with other spectrum users. Canadian regulations align closely with international standards, particularly those established by the International Telecommunication Union (ITU) and similar regulatory bodies in the United States and Europe, to facilitate interoperability and innovation while protecting incumbent services[61].

The permitted frequency ranges for UWB applications in Canada typically fall between 3.1 GHz and 10.6 GHz, with restrictions on emission levels to prevent interference with licensed services, including mobile communications, GPS, and radar systems.[62] UWB is primarily used for short-range applications such as indoor positioning, automotive radar, and secure data transfer. The spectrum framework in Canada aims to balance fostering innovation in emerging technologies like UWB with maintaining the integrity of existing communications infrastructure, ensuring a dynamic yet controlled environment for technological advancement.

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[61] Spectrum Management and Telecommunications Radio Standards Specification (2018) "Devices using UWB Technology". Retrieved in: https://ised-isde.canada.ca/site/spectrum-management-telecommunications/en/devices-and-equipment/radio-equipment-standards/radio-standards-specifications-rss/rss-220-devices-using-UWB-uwb-technology

[62] Source: https://ised-isde.canada.ca/site/spectrum-management-telecommunications/sites/default/files/attachments/2022/2018_Canadian_Radio_Spectrum_Chart.PDF

6.3. UWB social and economic value in the United Kingdom

The United Kingdom's UWB market illustrates a measured but expanding level of adoption across both consumer and industrial domains. While smart home and mobility use cases have led initial uptake, emerging applications in retail, industrial tracking, and public transportation are increasingly complementing this growth. For instance, "parking garage access control" demonstrates a notable jump from 1.10 million units in 2024 to 5.00 million by 2030, highlighting a shift toward more automated and UWB-enabled mobility solutions. These figures collectively underline the country's steady pivot toward UWB technology, as well as the broadening scope for its socio-economic impact in the coming years (see Table 6-5).

Table 6-5. United Kingdom: Units by use case

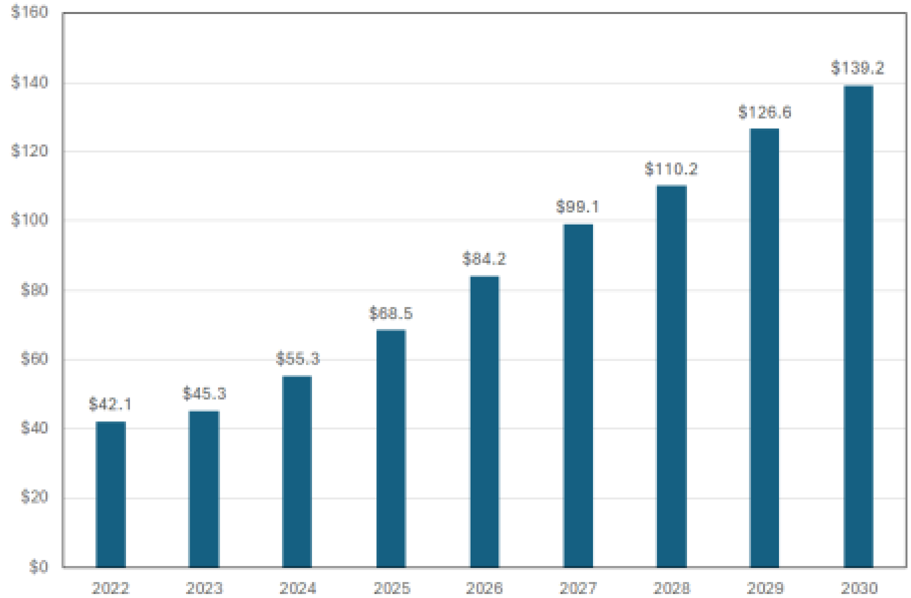
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	5.96	1.84%	14.34	1.41%
	Residential access control	0.14	1.84%	0.73	1.41%
	Easy (logistical) access to personal devices	0.01	1.84%	0.08	1.41%
	All gaming	0.13	1.84%	0.71	1.41%
	Audio streaming	0.00	1.84%	0.12	1.41%
	Gesture-based control	0.14	1.84%	0.73	1.41%
	VR gaming and group play	0.13	1.84%	0.71	1.41%
	Find someone/something nearby	0.58	1.84%	1.73	1.41%
	Smart speaker	0.29	1.84%	0.66	1.41%
	Presence-based device activation	0.00	1.84%	0.20	1.41%
Mobility	Parking garage access control	1.10	4.40%	5.00	3.51%
	Indoor navigation	1.10	4.40%	5.00	3.51%
	Vehicle digital key (car access)	0.22	4.40%	1.17	3.51%
	Rider identification in private transport services	5.11	1.84%	12.71	1.41%
	eID validation in crowded environments	5.11	1.84%	12.71	1.41%
	V2X and autonomous driving	1.10	4.40%	5.00	3.51%
	Driverless valet parking	1.10	4.40%	5.00	3.51%
	EV charging	0.34	4.40%	1.57	3.51%
	Toll collection	1.10	4.40%	5.00	3.51%
	Open trunk with gesture	0.03	4.40%	0.16	3.51%
	In cabin sensing	0.08	4.40%	1.05	3.51%
Individual consumer	Smart watches	0.85	1.84%	1.63	1.41%
	UWB smartphones	5.11	1.84%	12.71	1.41%
Smart retail	Tap-free mobile payment	5.11	1.84%	12.71	1.41%
	Unmanned store access	0.22	2.58%	0.78	2.65%
	Foot traffic and shopping behavior analytics	0.22	2.58%	0.78	2.65%
	Exhibition attendee management	0.22	2.58%	0.78	2.65%
	Targeted marketing	0.22	2.58%	0.78	2.65%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Drone controlled delivery	0.81	2.58%	3.24	2.65%
	In-vehicle payment	1.10	4.40%	5.00	3.51%
Industrial	Indoor navigation	0.22	2.58%	0.78	2.65%
	Proximity-based patient data sharing	0.17	2.58%	0.73	2.65%
	Teleconference system	0.04	2.58%	0.38	2.65%
	Patient tracking	0.17	2.58%	0.73	2.65%
	Industrial real-time location systems	0.22	2.58%	0.78	2.65%
Public transportation	Ticket validation	5.11	1.84%	12.71	1.41%
	Reserved seat validation	5.11	1.84%	12.71	1.41%
	Ride sharing (precise positioning)	5.11	1.84%	12.71	1.41%
	Transportation sharing (find a bike or scooter nearby)	5.11	1.84%	12.71	1.41%
	Transportation fare payment	5.11	1.84%	12.71	1.41%
Smart building	Physical Access control	5.11	1.84%	12.71	1.41%
	Controlled access	5.11	1.84%	12.71	1.41%
	Employee gathering in emergencies	5.11	1.84%	12.71	1.41%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

The United Kingdom's UWB contribution to GDP is forecast to reach USD 55.3 million by 2024, reflecting a modest but growing market for UWB-based products and services. By 2030, this figure is anticipated to rise further to USD 139.2 million, underscoring the country's steady progression in adopting UWB solutions across areas such as mobility, retail, and industrial automation. Cumulatively, from 2022 through 2030, these contributions are projected to total approximately USD 770.6 million, highlighting how incremental annual gains coalesce into a substantial impact on the UK's overall economic output (see Graphic 6-7).

Graphic 6-7. United Kingdom: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

The United Kingdom's UWB rollout is projected to generate a steady rise in employment over the coming years, reflecting the growing need for specialized skills in device manufacturing, software development, and service deployment. By 2024, UWB-related activities are expected to create 345 job/years, rising to 869 job/years by 2030. Cumulatively, from 2022 through 2030, this growth translates into an estimated 4,809 job/years, emphasizing the long-term labor market implications of UWB adoption as it expands across multiple sectors (see Table 6-6).

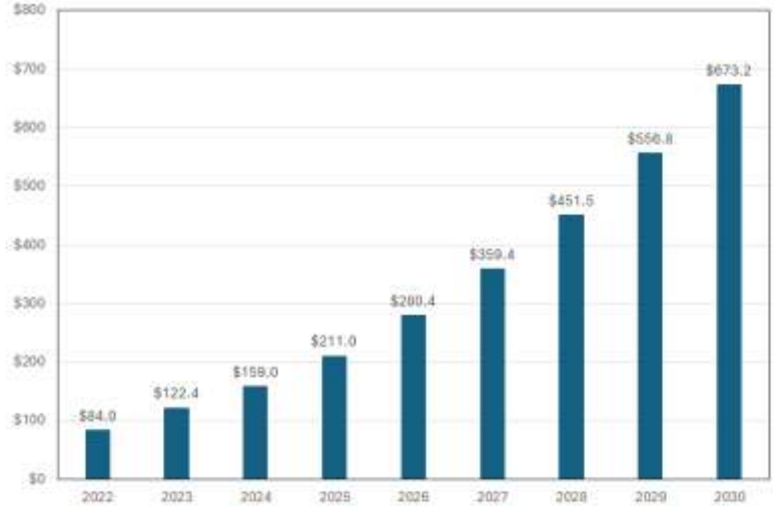
Table 6-6. United Kingdom: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
263	283	345	428	525	618	688	790	869	4,809

Source: Telecom Advisory Services analysis based on input/output matrix

The United Kingdom's producer surplus from UWB adoption illustrates the tangible operational gains that enterprises accrue as UWB-enabled processes become more widespread. By 2024, this surplus is forecast to reach USD 159.0 million, reflecting efficiencies gained in areas such as inventory management, location tracking, and automated workflows. By 2030, the surplus expands considerably, exceeding USD 673.2 million. Cumulatively, from 2022 through 2030, producer surplus in the UK is projected to total approximately USD 2.9 billion, underlining the significant economic advantages that UWB's adoption brings to a variety of industries (see Graphic 6-8).

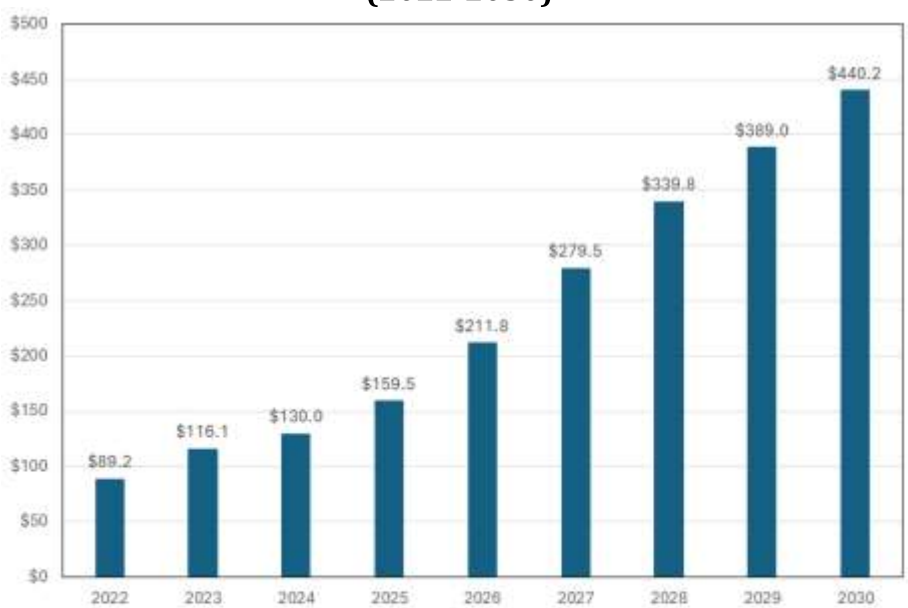
Graphic 6-8. United Kingdom: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

The United Kingdom's consumer surplus from UWB adoption reflects the growing convenience that everyday users experience in activities such as seamless payments, home automation, and location-based services. By 2024, this surplus is projected to reach USD 130.0 million, indicating that UWB capabilities are already filtering into mainstream consumer applications. By 2030, the figure rises substantially, surpassing USD 440.2 million. Cumulatively, between 2022 and 2030, consumer surplus in the UK is forecast to exceed USD 2.1 billion, illustrating how incremental year-on-year gains in UWB adoption coalesces into a sizeable long-term benefit for end-users (see Graphic 6-9).

Graphic 6-9. United Kingdom: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In the United Kingdom, UWB operations are supervised and authorized by OFCOM, the national telecommunications regulator. Aligned with the European regulatory framework, the UK adheres to technical and operational parameters for UWB established by the European Conference of Postal and Telecommunications Administrations (CEPT) and the International Telecommunication Union (ITU). UWB devices in the UK typically operate within the 3.1–10.6 GHz band under strict power spectral density limits, ensuring minimal interference with licensed services such as mobile and satellite communications, radar systems, and other critical spectrum users[63].

OFCOM's regulatory approach prioritizes innovation while safeguarding existing spectrum users. To achieve this, the UK enforces detailed emission masks and power restrictions consistent with European harmonized standards. These measures ensure that UWB's short-range, low-power transmissions coexist without disrupting neighboring frequency operations. While UWB is largely an unlicensed technology, manufacturers and service providers must adhere to coexistence conditions to mitigate interference risks. This harmonization across Europe benefits UWB stakeholders by supporting device interoperability, enabling economies of scale for components and end-user devices, and fostering the development of new UWB applications.

Looking forward, OFCOM actively evaluates emerging UWB use cases, such as secure proximity-based payments and precise industrial tracking, to determine whether regulatory updates are needed[64]. While the current framework supports a growing array of UWB-enabled consumer and enterprise applications, Ofcom remains open to future adjustments, including potential changes to operating bands or technical standards, to accommodate new innovations. This proactive and adaptive regulatory stance reflects Ofcom's commitment to fostering UWB's contribution to economic growth while ensuring robust protection for incumbent services.

6.4. UWB social and economic value in Germany

Germany's UWB landscape reflects a pronounced emphasis on industrial and mobility-focused applications, complemented by growing consumer-oriented segments. Notable examples include "parking garage access control," which is projected to increase from 1.80 million units in 2024 to 8.21 million by 2030, illustrating a surge in automated and location-sensitive capabilities. Similarly, adoption patterns in smart retail and public transportation signal a broadening scope for UWB's integration into daily life, from streamlined payment systems to more precise vehicle and passenger tracking. These developments collectively underscore Germany's trajectory toward expanded UWB deployment, driving both economic efficiencies and user convenience (see Table 6-7).

[63] https://www.ofcom.org.uk/phones-and-broadband/telecoms-infrastructure/uwb/
[64] https://www.ofcom.org.uk/spectrum/radio-equipment/uwb-regulations/

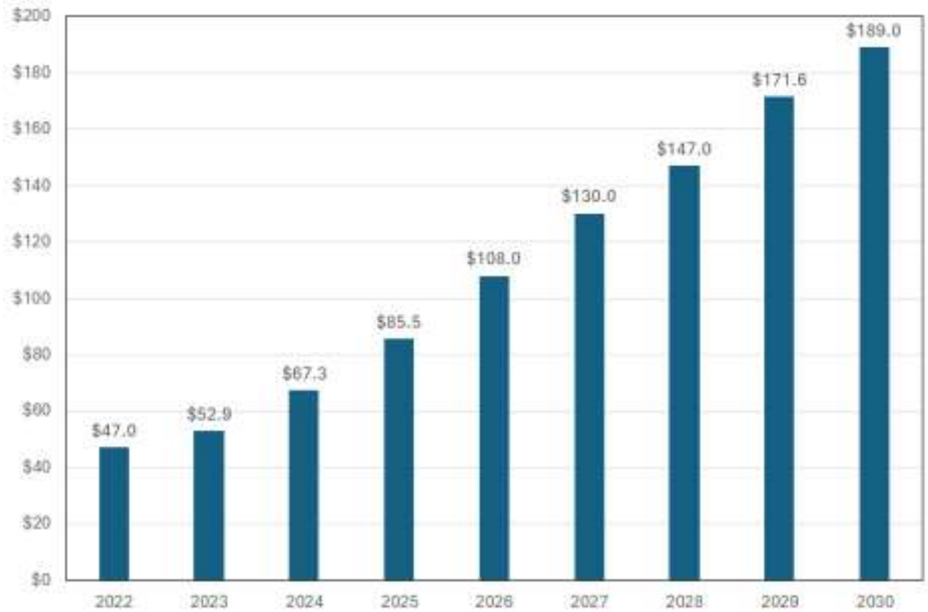
Table 6-7. Germany: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	5.73	1.77%	18.76	1.84%
	Residential access control	0.13	1.77%	0.96	1.84%
	Easy (logistical) access to personal devices	0.01	1.77%	0.11	1.84%
	All gaming	0.13	1.77%	0.93	1.84%
	Audio streaming	0.00	1.77%	0.16	1.84%
	Gesture-based control	0.13	1.77%	0.96	1.84%
	VR gaming and group play	0.13	1.77%	0.93	1.84%
	Find someone/something nearby	0.55	1.77%	2.26	1.84%
	Smart speaker	0.28	1.77%	0.86	1.84%
	Presence-based device activation	0.00	1.77%	0.26	1.84%
Mobility	Parking garage access control	1.80	7.23%	8.21	5.76%
	Indoor navigation	1.80	7.23%	8.21	5.76%
	Vehicle digital key (car access)	0.37	7.23%	1.92	5.76%
	Rider identification in private transport services	4.91	1.77%	16.63	1.84%
	eID validation in crowded environments	4.91	1.77%	16.63	1.84%
	V2X and autonomous driving	1.80	7.23%	8.21	5.76%
	Driverless valet parking	1.80	7.23%	8.21	5.76%
	EV charging	0.56	7.23%	2.58	5.76%
	Toll collection	1.80	7.23%	8.21	5.76%
	Open trunk with gesture	0.05	7.23%	0.26	5.76%
	In cabin sensing	0.13	7.23%	1.73	5.76%
Individual consumer	Smart watches	0.82	1.77%	2.13	1.84%
	UWB smartphones	4.91	1.77%	16.63	1.84%
Smart retail	Tap-free mobile payment	4.91	1.77%	16.63	1.84%
	Unmanned store access	0.28	3.39%	0.98	3.32%
	Foot traffic and shopping behavior analytics	0.28	3.39%	0.98	3.32%
	Exhibition attendee management	0.28	3.39%	0.98	3.32%
	Targeted marketing	0.28	3.39%	0.98	3.32%
	Drone controlled delivery	1.06	3.39%	4.07	3.32%
	In-vehicle payment	1.80	7.23%	8.21	5.76%
Industrial	Indoor navigation	0.28	3.39%	0.98	3.32%
	Proximity-based patient data sharing	0.23	3.39%	0.91	3.32%
	Teleconference system	0.05	3.39%	0.47	3.32%
	Patient tracking	0.23	3.39%	0.91	3.32%
	Industrial real-time location systems	0.28	3.39%	0.98	3.32%
Public transportation	Ticket validation	4.91	1.77%	16.63	1.84%
	Reserved seat validation	4.91	1.77%	16.63	1.84%
	Ride sharing (precise positioning)	4.91	1.77%	16.63	1.84%
	Transportation sharing (find a bike or scooter nearby)	4.91	1.77%	16.63	1.84%
	Transportation fare payment	4.91	1.77%	16.63	1.84%
Smart building	Physical Access control	4.91	1.77%	16.63	1.84%
	Controlled access	4.91	1.77%	16.63	1.84%
	Employee gathering in emergencies	4.91	1.77%	16.63	1.84%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

Germany's UWB contribution to GDP is projected to reach approximately USD 67.3 million by 2024, reflecting a growing base of early implementations in areas such as industrial automation and location-based services. By 2030, this figure is anticipated to climb to around USD 189.0 million, showcasing an expanded integration of UWB capabilities into both consumer and enterprise use cases. Cumulatively, from 2022 through 2030, the total value is forecast to exceed USD 998 million, underscoring the longer-term economic impact as UWB-driven solutions become increasingly central to Germany's digital ecosystem (see Graphic 6-10).

Graphic 6-10. Germany: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

Germany's UWB rollout is expected to drive consistent job creation across multiple industry segments. By 2024, UWB-related activities are projected to create 336 job years, reflecting expanding implementation in automotive, industrial tracking, and consumer applications. By 2030, this figure is anticipated to reach 944 job years, underscoring the accelerating pace of adoption as more sectors integrate UWB for location-based services and automation. Over the full 2022 to 2030 period, the cumulative number of job years linked to UWB in Germany is estimated at 4,985, indicating a sustained increase in labor demand driven by the technology's growing economic footprint (see Table 6-8).

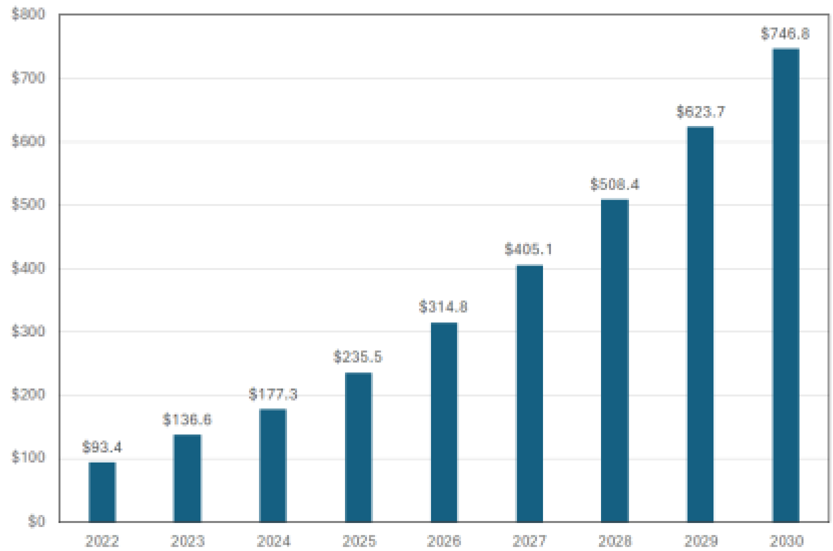
Table 6-8. Germany: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
235	264	336	427	539	649	734	857	944	4,985

Source: Telecom Advisory Services analysis based on input/output matrix

Germany's producer surplus from UWB adoption highlights the country's growing efficiency gains in areas such as manufacturing, logistics, and industrial automation. By 2024, this surplus is expected to reach USD 177.3 million, signaling the initial benefits arising from UWB integration in critical operations. By 2030, the figure is forecast to climb to USD 746.8 million, pointing to the compounded gains that emerge as UWB solutions become more deeply entrenched across multiple sectors. Cumulatively, between 2022 and 2030, Germany's producer surplus is anticipated to exceed USD 3.2 billion, underscoring the significant economic advantages stemming from widespread UWB deployment (see Graphic 6-11).

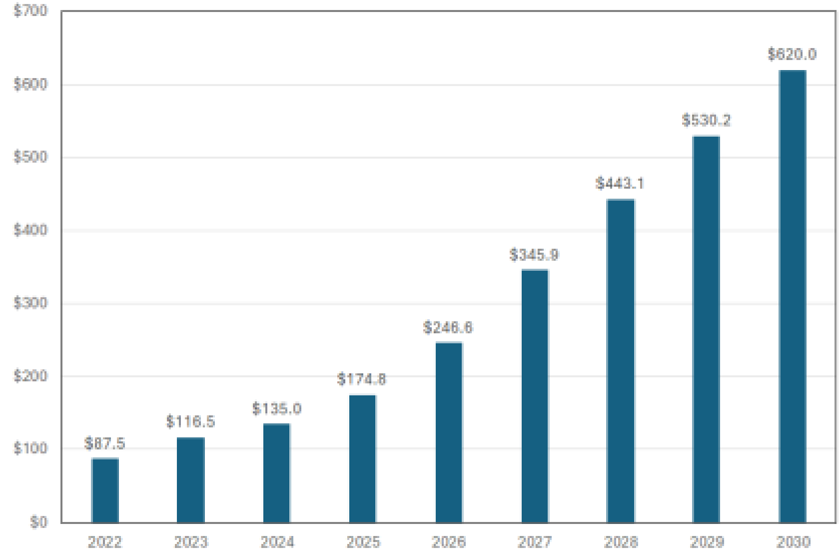
Graphic 6-11. Germany: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Germany's consumer surplus from UWB usage showcases the added convenience and time savings that UWB-enabled services bring to everyday life, from seamless in-home connectivity to enhanced personal mobility applications. By 2024, this surplus is projected to reach USD 135.0 million, indicating a notable midpoint in technology adoption. By 2030, it is expected to grow substantially, surpassing USD 620.0 million. Cumulatively, from 2022 through 2030, Germany's UWB-driven consumer surplus is forecast to exceed USD 2.7 billion, underscoring the long-term value that these incremental improvements provide to end users (see Graphic 6-12).

Graphic 6-12. Germany: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In Germany, the Bundesnetzagentur (BNetzA) serves as the primary authority overseeing UWB spectrum usage[65]. Like many other European nations, Germany adheres to harmonized European regulations, which define a set of technical rules and power masks for UWB devices to avoid harmful interference with incumbent services. These European frameworks stem from the European Commission's decisions and recommendations, supported by technical studies from bodies such as the European Conference of Postal and Telecommunications Administrations (CEPT) and the Electronic Communications Committee (ECC). In effect, UWB devices in Germany typically operate within the 3.1–10.6 GHz band, subject to strict limits on power spectral density.

Central to Germany's regulatory strategy is the principle of coexistence, wherein UWB is treated as an unlicensed, low-power technology that must not disrupt existing spectrum users—including radar, satellite communications, and licensed mobile services. To this end, BNetzA enforces maximum allowable emission levels, as well as specific operational constraints (such as indoor-only usage or additional power reductions) for certain UWB-based applications. Manufacturers and service providers consequently must ensure that UWB equipment marketed in Germany conforms to these European-wide emissions and safety standards, thereby facilitating device interoperability across borders[66].

Germany's long-term outlook for UWB regulation remains adaptable. As new use cases—ranging from high-precision industrial monitoring to advanced consumer services—continue to arise, BNetzA periodically engages with industry, research institutions, and

[65] Source: https://www.bundesnetzagentur.de/EN/Areas/Telecommunications/Technology/Standardisation/RadioApplications/UWB/UWB_node.html

[66] Source: https://docdb.cept.org/download/4215

international partners to re-evaluate established emission masks or consider additional frequencies for UWB operations. This measured approach, balancing innovation with interference protection, allows Germany's UWB ecosystem to evolve while maintaining reliable performance for incumbent spectrum users.

6.5. UWB social and economic value in the rest of the European continent

The rest of the Europe region reveals a rapidly expanding market for UWB-based solutions, encompassing both consumer-facing applications and more complex enterprise use cases. In particular, the anticipated growth in "point and trigger controller app" units from 43.65 million in 2024 to 134.75 million by 2030 underscores the high level of interest in smart home automation. Meanwhile, "parking garage access control" and "in-vehicle payment" also display marked increases, signaling a shift toward advanced mobility and retail services enabled by UWB. Altogether, these projections highlight the region's broadening adoption of UWB technology and the consequent gains in efficiency, convenience, and innovation (see Table 6-9).

Table 6-9. Rest of the Europe region: Units by use case

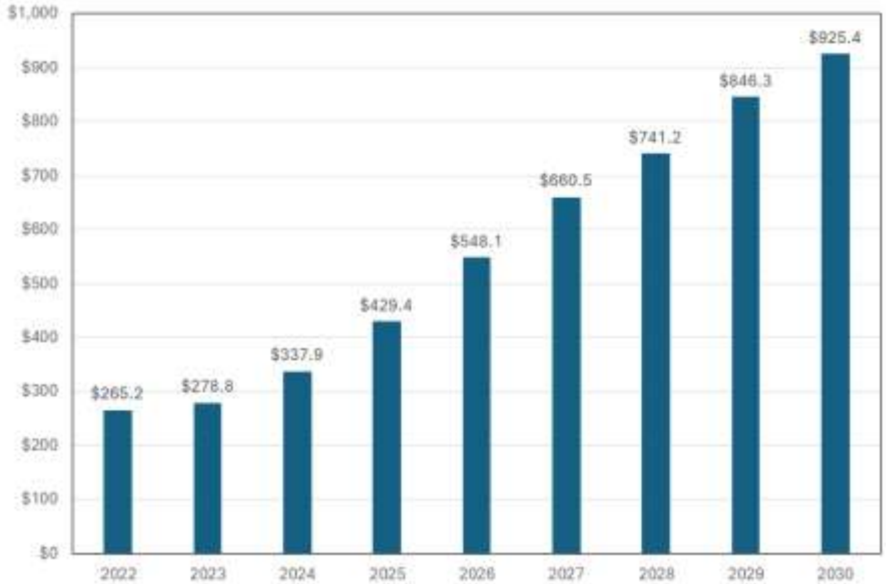
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	43.65	13.49%	134.75	13.25%
	Residential access control	1.01	13.49%	6.89	13.25%
	Easy (logistical) access to personal devices	0.07	13.49%	0.79	13.25%
	All gaming	0.95	13.49%	6.70	13.25%
	Audio streaming	0.00	13.49%	1.11	13.25%
	Gesture-based control	1.01	13.49%	6.89	13.25%
	VR gaming and group play	0.95	13.49%	6.70	13.25%
	Find someone/something nearby	4.22	13.49%	16.23	13.25%
	Smart speaker	2.14	13.49%	6.16	13.25%
	Presence-based device activation	0.00	13.49%	1.88	13.25%
Mobility	Parking garage access control	5.93	23.81%	27.01	18.96%
	Indoor navigation	5.93	23.81%	27.01	18.96%
	Vehicle digital key (car access)	1.21	23.81%	6.32	18.96%
	Rider identification in private transport services	37.40	13.49%	119.45	13.25%
	eID validation in crowded environments	37.40	13.49%	119.45	13.25%
	V2X and autonomous driving	5.93	23.81%	27.01	18.96%
	Driverless valet parking	5.93	23.81%	27.01	18.96%
	EV charging	1.86	23.81%	8.49	18.96%
	Toll collection	5.93	23.81%	27.01	18.96%
	Open trunk with gesture	0.17	23.81%	0.87	18.96%
	In cabin sensing	0.42	23.81%	5.68	18.96%
Individual consumer	Smart watches	6.25	13.49%	15.30	13.25%
	UWB smartphones	37.40	13.49%	119.45	13.25%
Smart retail	Tap-free mobile payment	37.40	13.49%	119.45	13.25%
	Unmanned store access	1.14	13.53%	3.99	13.58%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Foot traffic and shopping behavior analytics	1.14	13.53%	3.99	13.58%
	Exhibition attendee management	1.14	13.53%	3.99	13.58%
	Targeted marketing	1.14	13.53%	3.99	13.58%
	Drone controlled delivery	4.23	13.53%	16.64	13.58%
	In-vehicle payment	5.93	23.81%	27.01	18.96%
Industrial	Indoor navigation	1.14	13.53%	3.99	13.58%
	Proximity-based patient data sharing	0.90	13.53%	3.72	13.58%
	Teleconference system	0.22	13.53%	1.93	13.58%
	Patient tracking	0.90	13.53%	3.72	13.58%
	Industrial real-time location systems	1.14	13.53%	3.99	13.58%
Public transportation	Ticket validation	37.40	13.49%	119.45	13.25%
	Reserved seat validation	37.40	13.49%	119.45	13.25%
	Ride sharing (precise positioning)	37.40	13.49%	119.45	13.25%
	Transportation sharing (find a bike or scooter nearby)	37.40	13.49%	119.45	13.25%
	Transportation fare payment	37.40	13.49%	119.45	13.25%
Smart building	Physical Access control	37.40	13.49%	119.45	13.25%
	Controlled access	37.40	13.49%	119.45	13.25%
	Employee gathering in emergencies	37.40	13.49%	119.45	13.25%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

The rest of the Europe region is forecast to see its UWB-related GDP contribution grow from an estimated USD 337.9 million in 2024 to USD 925.4 million by 2030, reflecting the increasing importance of UWB across a wide range of industries. Over the 2022 to 2030 period, these annual increments are projected to sum to approximately USD 5.0 billion, underscoring how gradual market adoption and technological refinements can collectively drive significant economic gains. This trajectory highlights the region's capacity to leverage UWB for improved industrial processes, streamlined consumer services, and enhanced connectivity (see Graphic 6-13).

Graphic 6-13. Rest of the Europe region: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

The rest of the Europe region's UWB deployment is anticipated to generate a substantial volume of new jobs, fueled by both the direct demand for UWB-related hardware and services, and the indirect growth in ancillary sectors. By 2024, UWB adoption is projected to create 1,877 job years, expanding further to 5,111 job years by 2030. Cumulatively, from 2022 through 2030, this expansion is forecast to yield 27,863 job years across the region, reflecting the widespread integration of UWB capabilities in industrial processes, consumer applications, and infrastructure support (see Table 6-10).

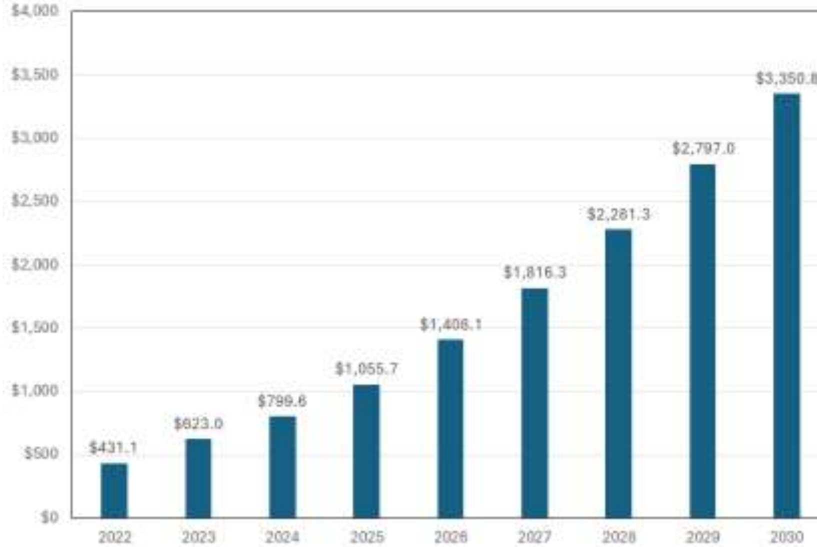
Table 6-10. Rest of the Europe region: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
1,482	1,552	1,877	2,383	3,035	3,652	4,098	4,674	5,111	27,863

Source: Telecom Advisory Services analysis based on input/output matrix

The rest of the Europe region's producer surplus from UWB adoption underscores the growing operational advantages that enterprises gain as UWB solutions mature. By 2024, the surplus is projected to reach approximately USD 799.6 million, reflecting a mid-stage point in the technology's business adoption curve. By 2030, it is expected to climb substantially, surpassing USD 3,350.8 million, demonstrating the compounding benefits that arise from widespread UWB-enabled optimization. Cumulatively, from 2022 through 2030, this surplus is forecast to exceed USD 14.5 billion, illustrating how incremental yearly gains ultimately translate into a significant economic impact for the region's industries (see Graphic 6-14).

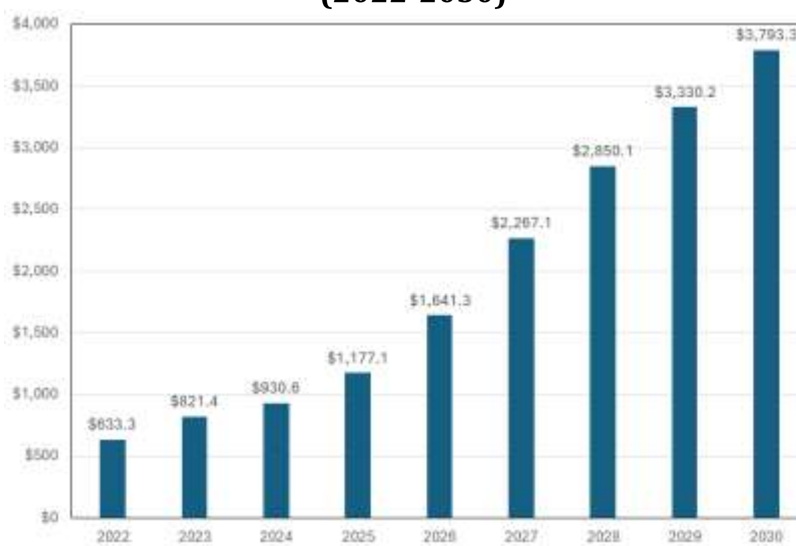
Graphic 6-14. Rest of the Europe region: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

The rest of the Europe region's consumer surplus from UWB highlights the expanding convenience that everyday users derive from UWB-enabled applications, including simplified payments and improved location-based services. By 2024, this surplus is projected to stand at USD 930.6 million, reflecting mid-level adoption across various consumer segments. By 2030, it is expected to surge beyond USD 3,793.3 million, illustrating the cumulative effect of increasing familiarity and widespread integration of UWB solutions. Over the entire 2022–2030 period, this surplus is forecast to exceed USD 17.4 billion, underscoring how incremental gains each year can coalesce into a significant, long-term boost to consumer welfare (see Graphic 6-15).

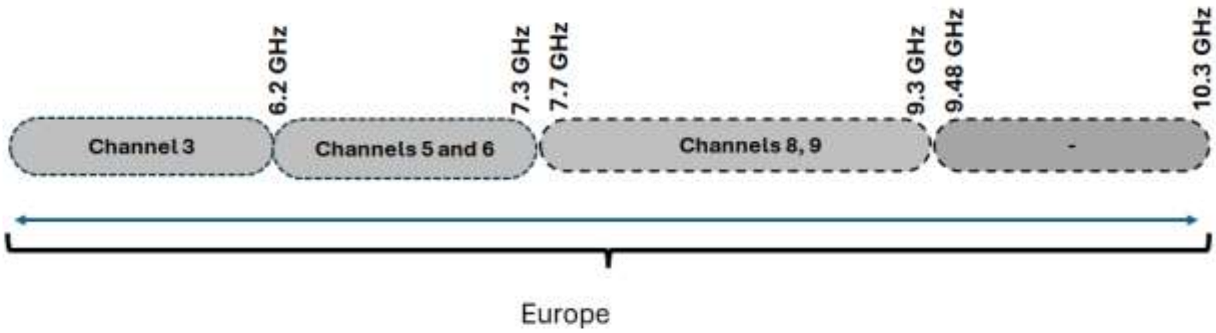
Graphic 6-15. Rest of the Europe region: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

UWB operations across Europe are governed by a harmonized regulatory framework established through the European Commission's directives and guided by the European Conference of Postal and Telecommunications Administrations (CEPT) and its Electronic Communications Committee (ECC). As illustrated in Figure 6-2 (Europe: UWB spectrum allocation), devices are permitted to operate across multiple channels spanning various frequency bands. These allocations enable innovative UWB applications while ensuring coexistence with incumbent services such as licensed mobile networks and satellite systems.

Figure 6-2. Europe: UWB spectrum allocation



NOTE: Channel 3 with mitigation techniques not suitable for end user applications
Source: FIRA

In particular, frequencies below 1.6 GHz are allocated for unlicensed UWB operation at a power spectral density (PSD) limit of −90-90−90 dBm/MHz, provided devices are not used at a fixed outdoor location. Additionally, in road/rail vehicles, Transmit Power Control (TPC) with a 12 dB range must be implemented, and the exterior limit of the maximum mean e.i.r.p. spectral density is −53.3-53.3−53.3 dBm/MHz. The 1.6–2.7 GHz band has a PSD limit of −85-85−85 dBm/MHz, governed by ECC/DEC/(06)04, stating that vehicular access systems must include trigger-before-transmit or a low duty cycle (LDC ≤0.5%\leq 0.5\%≤0.5% in 1 hour) or TPC. Between 2.7–3.4 GHz, the limit is −70-70−70 dBm/MHz (refer to ECC/DEC/(06)04 for details), while 3.4–3.8 GHz is capped at −80-80−80 dBm/MHz. The 3.8–4.2 GHz, 4.2–4.8 GHz, and 4.8–6 GHz bands all have limits of −70-70−70 dBm/MHz, and 6.0–8.5 GHz operates at −41.3-41.3−41.3 dBm/MHz. Moving up the spectrum, 8.5–10.6 GHz is limited to −65-65−65 dBm/MHz, and any frequencies above 10.6 GHz adhere to −85-85−85 dBm/MHz[67].

These strict PSD limits, typically −41.3-41.3−41.3 dBm/MHz in the core UWB bands (e.g., 6.0–8.5 GHz), ensure that UWB's low-power, short-range transmissions do not cause harmful interference to other spectrum users. All cited frequency bands have already been allocated, offering a coherent framework that promotes UWB innovation across Europe. By maintaining low emission levels and implementing measures like TPC, LDC, and trigger-before-transmit mechanisms, regulators have enabled a flexible and unlicensed approach that supports emerging UWB applications while protecting existing services.

[67] Source: APT Report on UWB (2024)

The European framework emphasizes unlicensed access balanced by interference protection. Devices must comply with specific emission masks and operational restrictions, such as prohibitions on fixed outdoor use and requirements for mitigation techniques like Transmit Power Control (TPC) and Low Duty Cycle (LDC) for certain applications. These conditions not only minimize potential disruption to neighboring spectrum users but also promote interoperability and harmonization across European markets. This regulatory consistency facilitates the development and deployment of UWB technologies in key areas such as automotive systems, smart infrastructure, and consumer electronics[68].

European regulators maintain an adaptive stance to support innovation while safeguarding spectrum integrity. Collaborative efforts with industry stakeholders, public authorities, and research institutions enable periodic evaluations of technical parameters and emission limits. For instance, restrictions on fixed outdoor use and specific operational bands—such as the mandated use of TPC for vehicular systems—are reviewed to accommodate emerging technologies and applications. This approach ensures that UWB regulations remain flexible and capable of supporting both technological advancements and the reliable operation of incumbent services.

6.6. UWB social and economic value in Mexico

Mexico is projected to experience a modest yet steadily expanding adoption of Ultra-Wideband technology across various sectors, with particular emphasis on consumer convenience and streamlined mobility. The data suggest that solutions such as "point and trigger controller app" will grow from 1.92 million units in 2024 to 8.28 million by 2030, indicating broader integration within smart home ecosystems. Meanwhile, areas like "rider identification in private transport services" and "tap-free mobile payment" illustrate the rising relevance of real-time location and secure transaction capabilities. As shown below, these developments point to a gradual but meaningful shift toward UWB deployment, enhancing both day-to-day efficiencies and overall economic potential (see Table 6-11).

[68] Source: APT Report on UWB (2024)

Table 6-11. Mexico: Units by use case

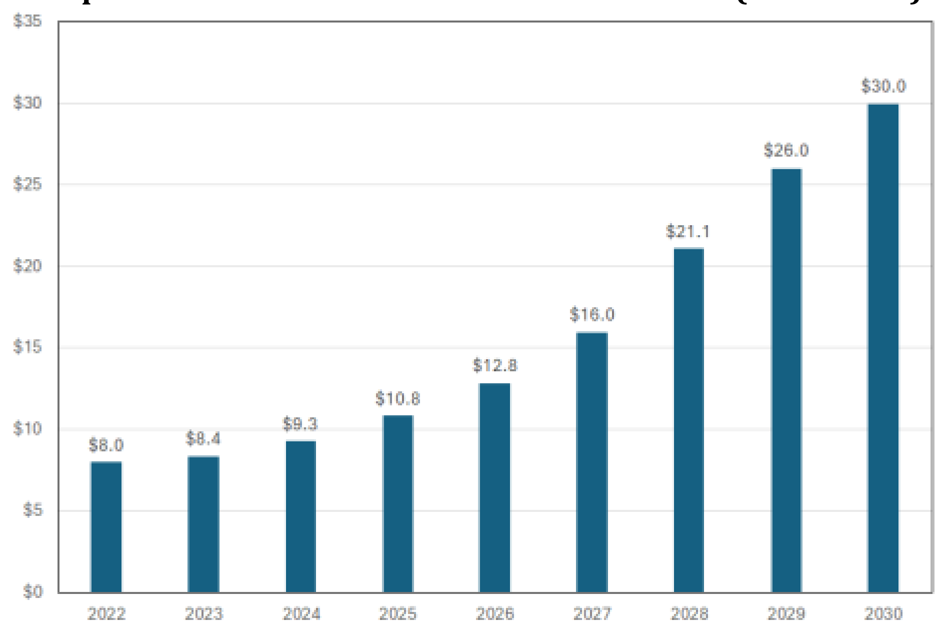
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	1.92	0.59%	8.28	0.81%
	Residential access control	0.04	0.59%	0.42	0.81%
	Easy (logistical) access to personal devices	0.00	0.59%	0.05	0.81%
	All gaming	0.04	0.59%	0.41	0.81%
	Audio streaming	0.00	0.59%	0.07	0.81%
	Gesture-based control	0.04	0.59%	0.42	0.81%
	VR gaming and group play	0.04	0.59%	0.41	0.81%
	Find someone/something nearby	0.19	0.59%	1.00	0.81%
	Smart speaker	0.09	0.59%	0.38	0.81%
	Presence-based device activation	0.00	0.59%	0.12	0.81%
Mobility	Parking garage access control	0.05	0.21%	0.10	0.07%
	Indoor navigation	0.05	0.21%	0.10	0.07%
	Vehicle digital key (car access)	0.01	0.21%	0.02	0.07%
	Rider identification in private transport services	1.64	0.59%	7.34	0.81%
	eID validation in crowded environments	1.64	0.59%	7.34	0.81%
	V2X and autonomous driving	0.05	0.21%	0.10	0.07%
	Driverless valet parking	0.05	0.21%	0.10	0.07%
	EV charging	0.02	0.21%	0.03	0.07%
	Toll collection	0.05	0.21%	0.10	0.07%
	Open trunk with gesture	0.00	0.21%	0.00	0.07%
	In cabin sensing	0.00	0.21%	0.02	0.07%
Individual consumer	Smart watches	0.27	0.59%	0.94	0.81%
	UWB smartphones	1.64	0.59%	7.34	0.81%
Smart retail	Tap-free mobile payment	1.64	0.59%	7.34	0.81%
	Unmanned store access	0.01	0.17%	0.02	0.08%
	Foot traffic and shopping behavior analytics	0.01	0.17%	0.02	0.08%
	Exhibition attendee management	0.01	0.17%	0.02	0.08%
	Targeted marketing	0.01	0.17%	0.02	0.08%
	Drone controlled delivery	0.05	0.17%	0.10	0.08%
	In-vehicle payment	0.05	0.21%	0.10	0.07%
Industrial	Indoor navigation	0.01	0.17%	0.02	0.08%
	Proximity-based patient data sharing	0.01	0.17%	0.02	0.08%
	Teleconference system	0.00	0.17%	0.01	0.08%
	Patient tracking	0.01	0.17%	0.02	0.08%
	Industrial real-time location systems	0.01	0.17%	0.02	0.08%
Public transportation	Ticket validation	1.64	0.59%	7.34	0.81%
	Reserved seat validation	1.64	0.59%	7.34	0.81%
	Ride sharing (precise positioning)	1.64	0.59%	7.34	0.81%
	Transportation sharing (find a bike or scooter nearby)	1.64	0.59%	7.34	0.81%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Transportation fare payment	1.64	0.59%	7.34	0.81%
Smart building	Physical Access control	1.64	0.59%	7.34	0.81%
	Controlled access	1.64	0.59%	7.34	0.81%
	Employee gathering in emergencies	1.64	0.59%	7.34	0.81%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

Mexico's UWB contribution to GDP is projected to reach approximately USD 9.3 million by 2024, signaling early yet tangible progress in UWB adoption across key sectors such as mobility and retail. By 2030, this figure is anticipated to climb further to USD 30.0 million, reflecting broader integration of UWB solutions into everyday processes. Cumulatively, from 2022 through 2030, these annual increments are forecast to total around USD 142.3 million, underscoring the gradual but steady influence UWB is expected to exert on Mexico's economic output over the coming years (see Graphic 6-16).

Graphic 6-16. Mexico: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

Mexico's UWB rollout is forecast to create a growing number of job years as both technical and operational capacities scale up to meet rising demand for UWB solutions. By 2024, the industry is expected to add 231 job years, reflecting ongoing deployments in mobility, consumer applications, and logistics. By 2030, this figure is projected to surpass 900 job years, underscoring the accelerating pace of adoption. Taken together, from 2022 through 2030, these increases amount to a cumulative total of 3,740 job years, illustrating the expanding labor market implications of UWB in Mexico (see Table 6-12).

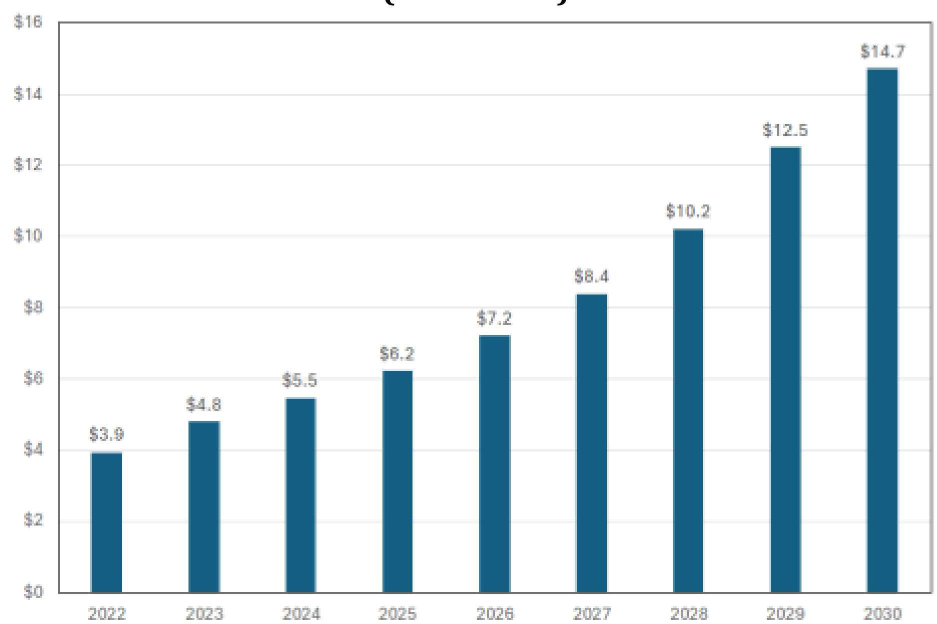
Table 6-12. Mexico: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
196	208	231	269	320	399	525	648	943	3,740

Source: Telecom Advisory Services analysis based on input/output matrix

Mexico's producer surplus from UWB adoption highlights the efficiency gains that enterprises can achieve as UWB solutions permeate sectors. By 2024, this surplus is projected to reach USD 5.5 million, indicating initial, yet meaningful, cost reductions and process enhancements driven by UWB. By 2030, it is forecast to climb to USD 14.7 million, reflecting more mature implementations and broader industry uptake. Cumulatively, from 2022 through 2030, these increments are anticipated to total approximately USD 73 million, underscoring the expanding role of UWB in boosting Mexico's industrial productivity over the longer term (see Graphic 6-17).

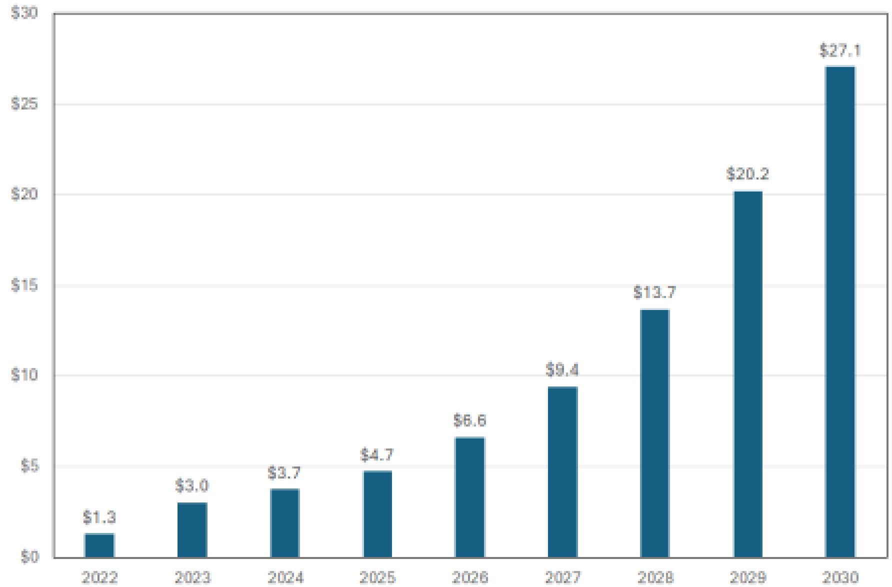
Graphic 6-17. Mexico: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Mexico's consumer surplus from UWB illustrates the incremental improvements in everyday conveniences. By 2024, this surplus is projected at USD 3.7 million, indicating a nascent but growing appreciation of UWB's benefits among consumers. By 2030, the figure rises markedly, reaching USD 27.1 million as adoption becomes more widespread. Taken cumulatively over the 2022–2030 period, these annual increases are expected to exceed USD 89 million, underscoring the gradual yet significant enhancement to consumer welfare that UWB can deliver (see Graphic 6-18).

Graphic 6-18. Mexico: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In Mexico, the Instituto Federal de Telecomunicaciones (IFT) serves as the primary authority overseeing UWB regulations and ensuring that UWB deployments do not interfere with incumbent spectrum services. While Mexico does not maintain standalone UWB regulations as extensive as those in some other regions, it generally aligns its technical requirements and emission masks with international standards, including those put forth by the International Telecommunication Union (ITU). As a result, UWB devices typically operate within the 3.1–10.6 GHz band, subject to stringent power spectral density limits aimed at minimizing the risk of harmful interference to licensed mobile, satellite, and radiolocation systems.

From a practical standpoint, Mexico's approach to UWB has been shaped in part by harmonization efforts with neighboring countries—particularly the United States—given the economic importance of cross-border trade and device interoperability. Consequently, UWB manufacturers marketing products in Mexico must demonstrate conformity with emission thresholds that align closely with North American norms. Nonetheless, the IFT reserves the right to apply additional technical or operational restrictions for particular UWB use cases when necessary to protect incumbent spectrum services (e.g., public safety communications or critical infrastructure monitoring)[69].

6.7. UWB social and economic value in Brazil

Brazil is projected to see a steady increase in UWB adoption across both consumer-focused solutions and enterprise-oriented applications. The data suggest that "tap-free mobile payment" units will expand from 2.49 million in 2024 to 12.40 million in 2030, indicating an accelerated uptake in real-time location and secure transaction technologies. Meanwhile,

[69] Source: https://www.ift.org.mx/politica-regulatoria/regulacion-tecnica

areas such as “smart home” and “mobility” also show notable growth trajectories, underscoring Brazil’s shifting reliance on UWB as a means to enhance convenience, optimize logistics, and improve overall connectivity (see Table 6-12).

Table 6-12. Brazil: Units by use case

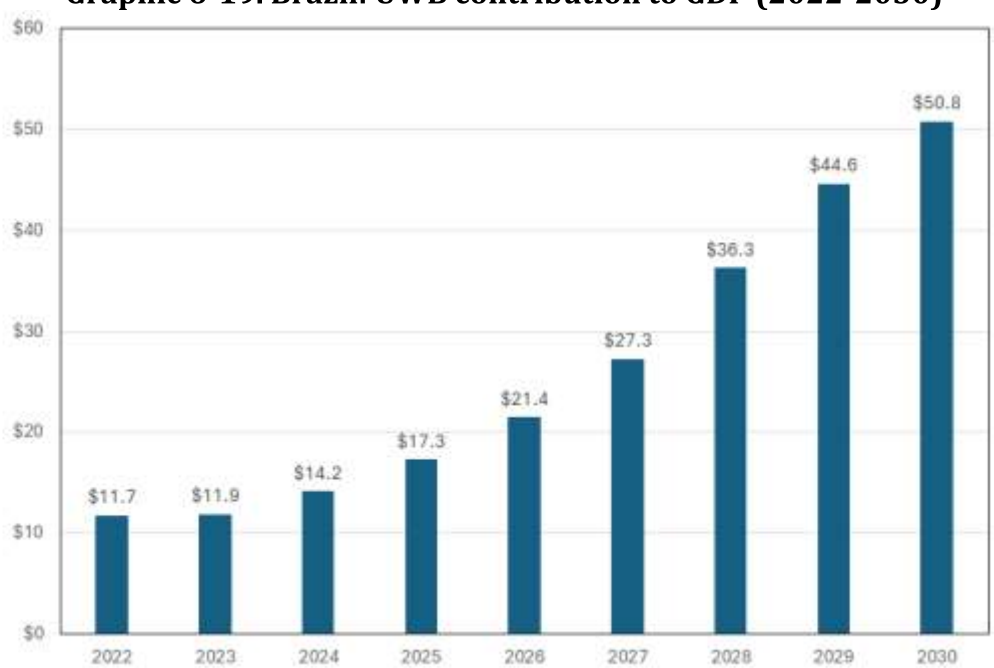
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	2.91	0.90%	13.99	1.38%
	Residential access control	0.07	0.90%	0.71	1.38%
	Easy (logistical) access to personal devices	0.00	0.90%	0.08	1.38%
	All gaming	0.06	0.90%	0.70	1.38%
	Audio streaming	0.00	0.90%	0.12	1.38%
	Gesture-based control	0.07	0.90%	0.71	1.38%
	VR gaming and group play	0.06	0.90%	0.70	1.38%
	Find someone/something nearby	0.28	0.90%	1.68	1.38%
	Smart speaker	0.14	0.90%	0.64	1.38%
	Presence-based device activation	0.00	0.90%	0.19	1.38%
Mobility	Parking garage access control	0.17	0.67%	0.31	0.22%
	Indoor navigation	0.17	0.67%	0.31	0.22%
	Vehicle digital key (car access)	0.03	0.67%	0.07	0.22%
	Rider identification in private transport services	2.49	0.90%	12.40	1.38%
	eID validation in crowded environments	2.49	0.90%	12.40	1.38%
	V2X and autonomous driving	0.17	0.67%	0.31	0.22%
	Driverless valet parking	0.17	0.67%	0.31	0.22%
	EV charging	0.05	0.67%	0.10	0.22%
	Toll collection	0.17	0.67%	0.31	0.22%
	Open trunk with gesture	0.00	0.67%	0.01	0.22%
	In cabin sensing	0.01	0.67%	0.07	0.22%
Individual consumer	Smart watches	0.42	0.90%	1.59	1.38%
	UWB smartphones	2.49	0.90%	12.40	1.38%
Smart retail	Tap-free mobile payment	2.49	0.90%	12.40	1.38%
	Unmanned store access	0.02	0.20%	0.03	0.11%
	Foot traffic and shopping behavior analytics	0.02	0.20%	0.03	0.11%
	Exhibition attendee management	0.02	0.20%	0.03	0.11%
	Targeted marketing	0.02	0.20%	0.03	0.11%
	Drone controlled delivery	0.06	0.20%	0.14	0.11%
	In-vehicle payment	0.17	0.67%	0.31	0.22%
Industrial	Indoor navigation	0.02	0.20%	0.03	0.11%
	Proximity-based patient data sharing	0.01	0.20%	0.03	0.11%
	Teleconference system	0.00	0.20%	0.02	0.11%
	Patient tracking	0.01	0.20%	0.03	0.11%
	Industrial real-time location systems	0.02	0.20%	0.03	0.11%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Public transportation	Ticket validation	2.49	0.90%	12.40	1.38%
	Reserved seat validation	2.49	0.90%	12.40	1.38%
	Ride sharing (precise positioning)	2.49	0.90%	12.40	1.38%
	Transportation sharing (find a bike or scooter nearby)	2.49	0.90%	12.40	1.38%
	Transportation fare payment	2.49	0.90%	12.40	1.38%
Smart building	Physical Access control	2.49	0.90%	12.40	1.38%
	Controlled access	2.49	0.90%	12.40	1.38%
	Employee gathering in emergencies	2.49	0.90%	12.40	1.38%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

Brazil's UWB contribution to GDP is forecast to reach USD 14.2 million by 2024, reflecting the early expansion of UWB technology across both consumer-facing and industrial arenas. By 2030, that figure is projected to climb substantially to USD 50.8 million, signaling broader market penetration and enhanced productivity benefits. Cumulatively, from 2022 through 2030, these incremental gains are estimated to exceed USD 235 million, underscoring the steadily growing role UWB is expected to play in Brazil's economic landscape (see Graphic 6-19).

Graphic 6-19. Brazil: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

Brazil's UWB deployment is poised to create a notable uptick in employment, reflecting the demand for specialized roles in device integration, software development, and system maintenance. By 2024, the implementation of UWB is expected to generate 353 job years, increasing to 1,599 job years by 2030. Over the entire 2022 to 2030 period, this expansion is projected to total 6,198 job years, illustrating the broad labor market implications of continued UWB adoption across Brazil's diverse economic sectors (see Table 6-13).

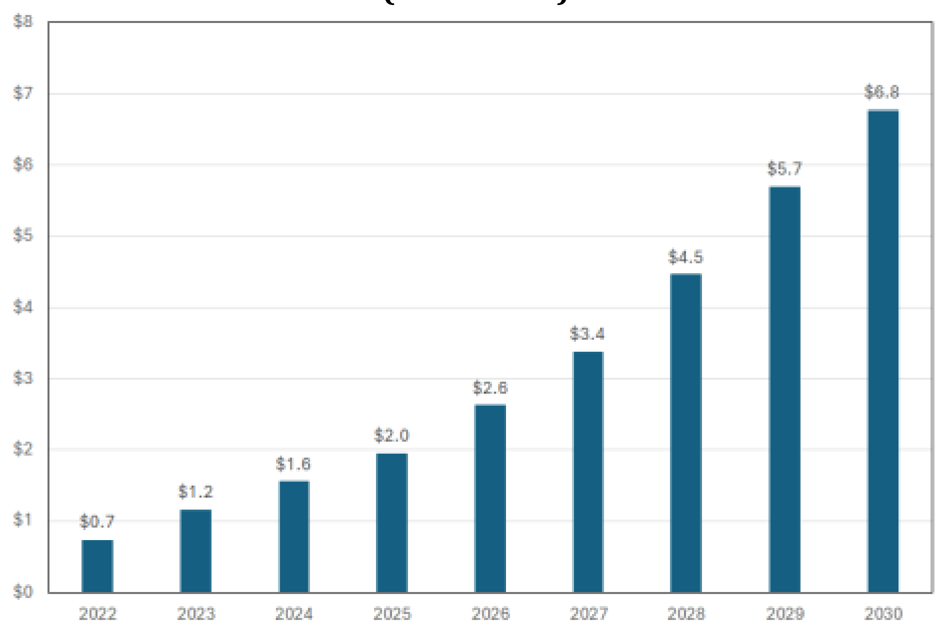
Table 6-13. Brazil: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
289	296	353	431	534	681	904	1,112	1,599	6,198

Source: Telecom Advisory Services analysis based on input/output matrix

Brazil's producer surplus from UWB highlights the operational and productivity benefits accrued by enterprises as UWB solutions become more deeply integrated. By 2024, this surplus is projected to reach approximately USD 1.6 million. By 2030, it is anticipated to climb to about USD 6.8 million, indicating a further acceleration of adoption and broader sectoral uptake. Cumulatively, between 2022 and 2030, these incremental improvements are forecast to surpass USD 28 million (see Graphic 6-20).

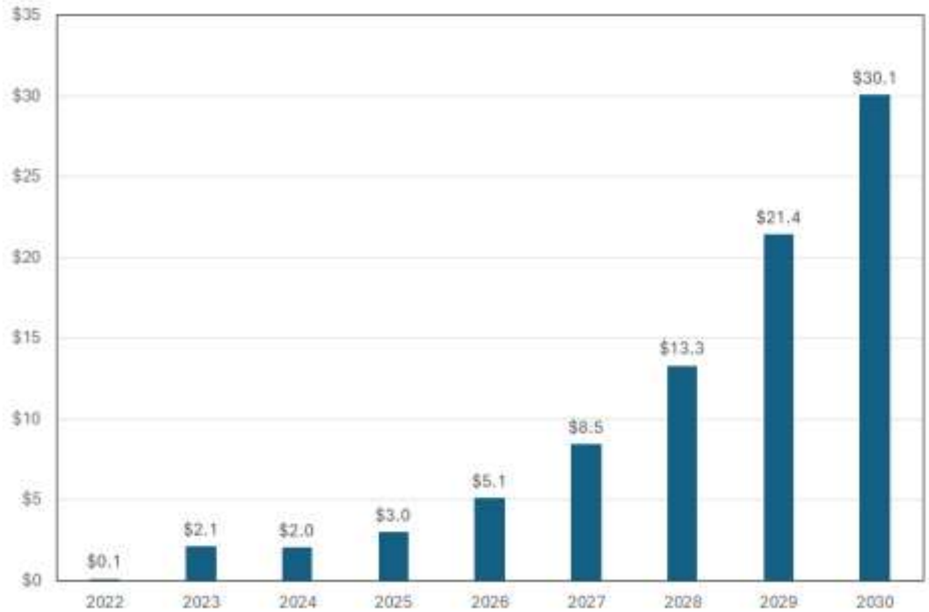
Graphic 6-20. Brazil: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Brazil's consumer surplus from UWB adoption reflects the tangible advantages that citizens gain through everyday conveniences, including streamlined payments and enhanced location-based services. By 2024, this surplus is projected to reach USD 2.0 million, indicating nascent yet meaningful uptake among end-users. By 2030, the figure increases dramatically to USD 30.1 million, driven by broader market penetration and more sophisticated UWB-enabled applications. Cumulatively, between 2022 and 2030, these annual gains are expected to surpass USD 85 million, underscoring how UWB contributes to improved quality of life and efficiency for Brazilian consumers (see Graphic 6-21).

Graphic 6-21. Brazil: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In Brazil, the Agência Nacional de Telecomunicações (ANATEL) is the principal authority supervising UWB spectrum usage and setting forth the guidelines designed to ensure that UWB devices do not interfere with incumbent services. While Brazil has historically followed international recommendations issued by organizations such as the International Telecommunication Union (ITU), the regulatory frameworks for UWB are continually assessed to account for the country's particular needs and developmental priorities. As in many other jurisdictions, typical UWB operations fall within the 3.1–10.6 GHz range and are subject to strict power emission constraints to minimize disruptions to licensed mobile networks, satellite systems, and radar services[70].

ANATEL's stance regarding UWB is shaped by two core objectives: (i) fostering technological innovation and market growth for short-range, low-power applications, and (ii) safeguarding incumbent users through rules on permissible emission levels, frequency bands, and device certifications[71]. Consequently, UWB equipment sold or deployed in Brazil must adhere to predefined emission masks and technical specifications designed to protect existing spectrum holders. ANATEL's conformity assessment processes verify that UWB

[70] Source: https://informacoes.anatel.gov.br/legislacao/atos-de-certificacao-de-produtos/2020/1467-ato-4776

[71] For instance, ANATEL's Ato nº 4776, de 01 de setembro de 2020, outlines technical requirements for the certification of vehicle radars operating in the 22-29 GHz frequency band, ensuring that such UWB devices do not cause harmful interference to existing services.

devices meet these standards before reaching consumers and enterprises, thereby sustaining a stable electromagnetic environment.

6.8. UWB social and economic value in the rest of Latin America

The rest of Latin America is poised for a notable expansion of UWB solutions, with both consumer-facing and enterprise applications expected to see rising penetration. For instance, projections show “point and trigger controller app” units increasing from 4.61 million in 2024 to 25.94 million in 2030, demonstrating robust smart home adoption in this region. Meanwhile, “rider identification in private transport services” stands out in the mobility domain, growing from 3.95 million units to 22.99 million over the same period. As shown below, these trends indicate that while the overall market share remains relatively modest today, significant scaling of UWB-driven technologies is on the horizon (see Table 6-15).

Table 6-15. Rest of Latin America: Units by use case

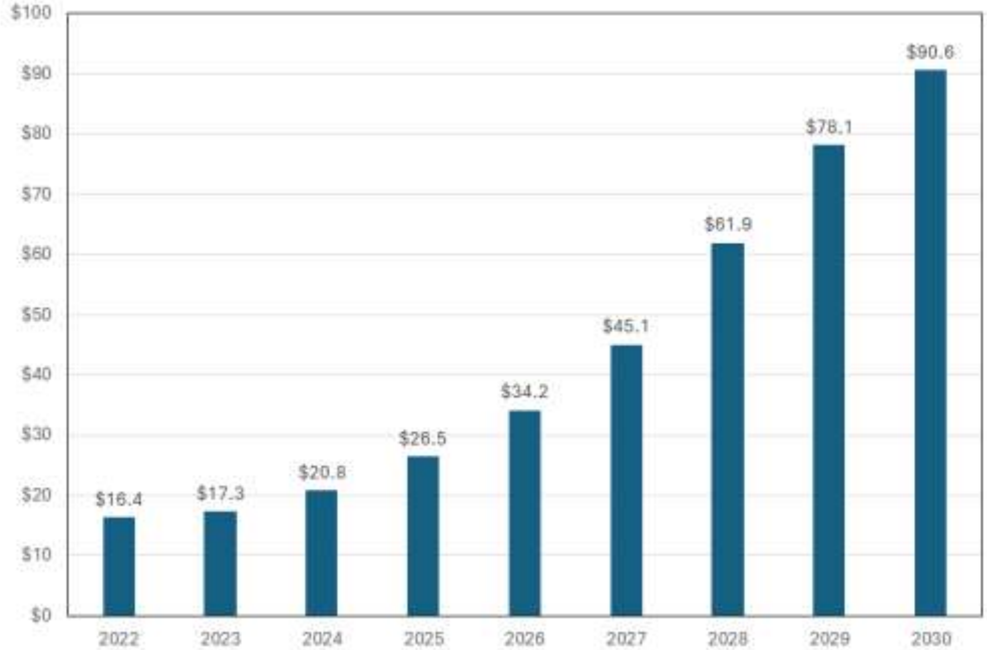
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	4.61	1.42%	25.94	2.55%
	Residential access control	0.11	1.42%	1.33	2.55%
	Easy (logistical) access to personal devices	0.01	1.42%	0.15	2.55%
	All gaming	0.10	1.42%	1.29	2.55%
	Audio streaming	0.00	1.42%	0.21	2.55%
	Gesture-based control	0.11	1.42%	1.33	2.55%
	VR gaming and group play	0.10	1.42%	1.29	2.55%
	Find someone/something nearby	0.45	1.42%	3.12	2.55%
	Smart speaker	0.23	1.42%	1.19	2.55%
	Presence-based device activation	0.00	1.42%	0.36	2.55%
Mobility	Parking garage access control	0.14	0.55%	0.26	0.18%
	Indoor navigation	0.14	0.55%	0.26	0.18%
	Vehicle digital key (car access)	0.03	0.55%	0.06	0.18%
	Rider identification in private transport services	3.95	1.42%	22.99	2.55%
	eID validation in crowded environments	3.95	1.42%	22.99	2.55%
	V2X and autonomous driving	0.14	0.55%	0.26	0.18%
	Driverless valet parking	0.14	0.55%	0.26	0.18%
	EV charging	0.04	0.55%	0.08	0.18%
	Toll collection	0.14	0.55%	0.26	0.18%
	Open trunk with gesture	0.00	0.55%	0.01	0.18%
	In cabin sensing	0.01	0.55%	0.05	0.18%
Individual consumer	Smart watches	0.66	1.42%	2.94	2.55%
	UWB smartphones	3.95	1.42%	22.99	2.55%
Smart retail	Tap-free mobile payment	3.95	1.42%	22.99	2.55%
	Unmanned store access	0.02	0.25%	0.04	0.13%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Foot traffic and shopping behavior analytics	0.02	0.25%	0.04	0.13%
	Exhibition attendee management	0.02	0.25%	0.04	0.13%
	Targeted marketing	0.02	0.25%	0.04	0.13%
	Drone controlled delivery	0.08	0.25%	0.16	0.13%
	In-vehicle payment	0.14	0.55%	0.26	0.18%
Industrial	Indoor navigation	0.02	0.25%	0.04	0.13%
	Proximity-based patient data sharing	0.02	0.25%	0.04	0.13%
	Teleconference system	0.00	0.25%	0.02	0.13%
	Patient tracking	0.02	0.25%	0.04	0.13%
	Industrial real-time location systems	0.02	0.25%	0.04	0.13%
Public transportation	Ticket validation	3.95	1.42%	22.99	2.55%
	Reserved seat validation	3.95	1.42%	22.99	2.55%
	Ride sharing (precise positioning)	3.95	1.42%	22.99	2.55%
	Transportation sharing (find a bike or scooter nearby)	3.95	1.42%	22.99	2.55%
	Transportation fare payment	3.95	1.42%	22.99	2.55%
Smart building	Physical Access control	3.95	1.42%	22.99	2.55%
	Controlled access	3.95	1.42%	22.99	2.55%
	Employee gathering in emergencies	3.95	1.42%	22.99	2.55%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

The rest of Latin America's UWB contribution to GDP is forecast to reach USD 20.8 million by 2024. By 2030, this figure is expected to climb substantially, surpassing USD 90.6 million, as broader market adoption and technological refinements take hold. Cumulatively, from 2022 through 2030, these annual increments are estimated to total approximately USD 391 million, highlighting the region's gradual yet notable progress in leveraging UWB to enhance economic output (see Graphic 6-22).

Graphic 6-22. Rest of Latin America: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

The rest of Latin America is poised to experience a notable expansion in UWB-related employment as both consumer and industrial sectors adopt the technology. By 2024, the region is expected to reach 519 job years, growing further to 2,850 by 2030. Over the entire period from 2022 to 2030, these cumulative additions are forecast to total 10,327 job years, underscoring the consistent labor market uplift that emerges alongside the increasing implementation of UWB solutions (see Table 6-16).

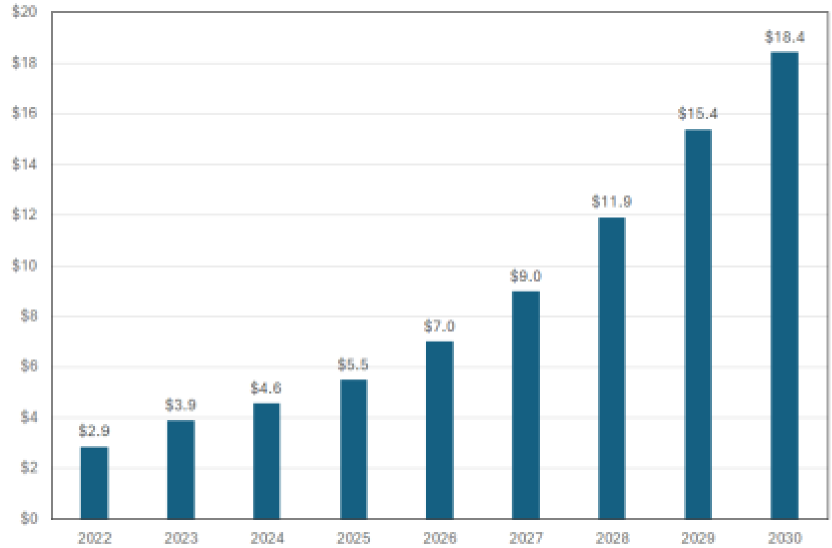
Table 6-16. Rest of Latin America: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
405	431	519	660	851	1,125	1,542	1,945	2,850	10,327

Source: Telecom Advisory Services analysis based on input/output matrix

The rest of Latin America's producer surplus from UWB reflects growing efficiencies that enterprises can achieve as the technology matures across diverse industries. By 2024, this surplus is projected to stand at USD 4.6 million. By 2030, it is anticipated to rise substantially to USD 18.4 million, driven by a broader range of UWB-enabled optimizations. Cumulatively, between 2022 and 2030, these incremental gains are estimated to exceed USD 78 million, underscoring the region's evolving reliance on UWB as a catalyst for operational improvements (see Graphic 6-23).

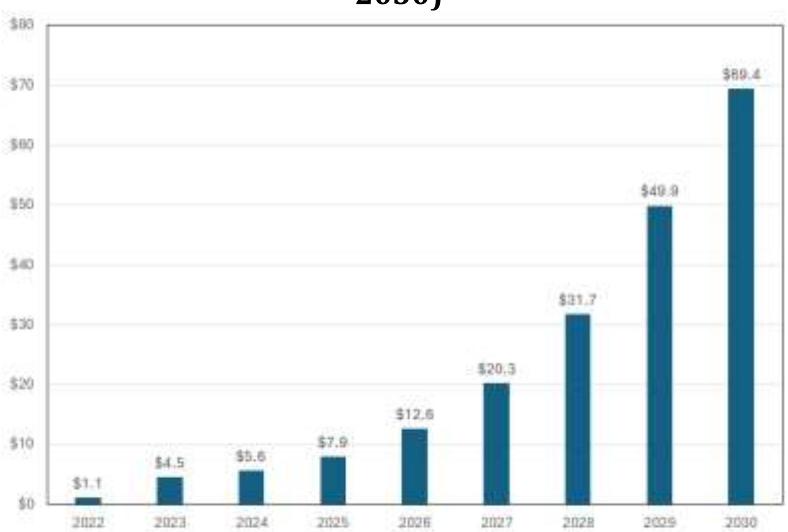
Graphic 6-23. Rest of Latin America: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

The rest of Latin America's consumer surplus from UWB demonstrates growing end-user benefits in daily activities. By 2024, this surplus is expected to reach USD 5.6 million, reflecting an early yet progressive uptake of UWB-enabled solutions among consumers. By 2030, the figure is projected to rise to USD 69.4 million, underscoring the surge in adoption as UWB technology expands its presence across multiple domains. Cumulatively, from 2022 through 2030, these enhancements are anticipated to surpass USD 203 million, illustrating the transformative potential of UWB in enhancing convenience and efficiency for users throughout the region (see Graphic 6-24).

Graphic 6-24. Rest of Latin America: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In the rest of Latin America, UWB regulation generally follows broad international guidelines—often modeled on frameworks developed by the International Telecommunication Union and, where applicable, informed by neighboring markets such as the United States or Brazil. While specific regulatory regimes vary among individual countries, most national authorities require UWB devices to conform to strict power spectral density thresholds, typically allowing operations in the 3.1–10.6 GHz band. These constraints aim to ensure that UWB's low-power, short-range transmissions do not cause harmful interference to incumbent users, which can include commercial mobile networks, satellite communications, and aeronautical or defense radar systems.

For countries outside the region's larger economies, harmonization and equipment interoperability play a crucial role. Given that many UWB chipsets and devices are imported or licensed from abroad, local regulators often strive to maintain technical consistency with globally recognized standards, thus reducing market-entry barriers. Regulatory bodies typically approve UWB devices through type-approval or conformity assessments, verifying that emission masks and operational parameters adhere to limits suitable for shared or adjacent frequencies.

For example, in Argentina, the regulatory framework for UWB technology is not explicitly defined by a specific regulatory body. However, in 2021, Apple expanded the availability of its U1 UWB chip to Argentina (and Paraguay), indicating that UWB technology is permitted in the country. Also, in Colombia, the Comisión de Regulación de Comunicaciones (CRC) has addressed inquiries regarding UWB technology. In a communication dated April 14, 2023, the CRC acknowledged the receipt of information requests about UWB, indicating that the technology is under consideration.

6.9. UWB social and economic value in South Africa

South Africa's UWB outlook projects a rising deployment across both everyday consumer applications and enterprise-level solutions, albeit on a relatively moderate scale compared to larger markets. For instance, "rider identification in private transport services" is forecast to expand from 1.10 million units in 2024 to 7.16 million by 2030, highlighting the growing importance of secure, real-time location functionalities. Other domains, such as smart homes and public transportation, show incremental but meaningful progress, suggesting that while the absolute numbers remain comparatively small, UWB technologies are set to gain traction in enhancing daily life and operational efficiencies in South Africa (see Table 6-17).

Table 6-17. South Africa: Units by use case

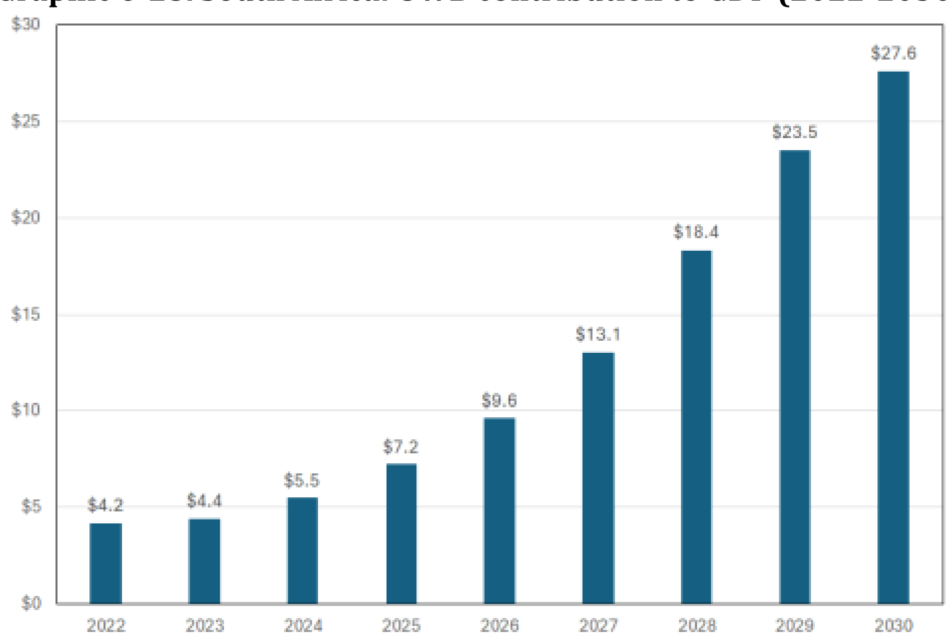
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	1.28	0.40%	8.07	0.79%
	Residential access control	0.03	0.40%	0.41	0.79%
	Easy (logistical) access to personal devices	0.00	0.40%	0.05	0.79%
	All gaming	0.03	0.40%	0.40	0.79%
	Audio streaming	0.00	0.40%	0.07	0.79%
	Gesture-based control	0.03	0.40%	0.41	0.79%
	VR gaming and group play	0.03	0.40%	0.40	0.79%
	Find someone/something nearby	0.12	0.40%	0.97	0.79%
	Smart speaker	0.06	0.40%	0.37	0.79%
	Presence-based device activation	0.00	0.40%	0.11	0.79%
Mobility	Parking garage access control	0.04	0.15%	0.07	0.05%
	Indoor navigation	0.04	0.15%	0.07	0.05%
	Vehicle digital key (car access)	0.01	0.15%	0.02	0.05%
	Rider identification in private transport services	1.10	0.40%	7.16	0.79%
	eID validation in crowded environments	1.10	0.40%	7.16	0.79%
	V2X and autonomous driving	0.04	0.15%	0.07	0.05%
	Driverless valet parking	0.04	0.15%	0.07	0.05%
	EV charging	0.01	0.15%	0.02	0.05%
	Toll collection	0.04	0.15%	0.07	0.05%
	Open trunk with gesture	0.00	0.15%	0.00	0.05%
	In cabin sensing	0.00	0.15%	0.02	0.05%
Individual consumer	Smart watches	0.18	0.40%	0.92	0.79%
	UWB smartphones	1.10	0.40%	7.16	0.79%
Smart retail	Tap-free mobile payment	1.10	0.40%	7.16	0.79%
	Unmanned store access	0.00	0.04%	0.01	0.02%
	Foot traffic and shopping behavior analytics	0.00	0.04%	0.01	0.02%
	Exhibition attendee management	0.00	0.04%	0.01	0.02%
	Targeted marketing	0.00	0.04%	0.01	0.02%
	Drone controlled delivery	0.01	0.04%	0.02	0.02%
	In-vehicle payment	0.04	0.15%	0.07	0.05%
Industrial	Indoor navigation	0.00	0.04%	0.01	0.02%
	Proximity-based patient data sharing	0.00	0.04%	0.00	0.02%
	Teleconference system	0.00	0.04%	0.00	0.02%
	Patient tracking	0.00	0.04%	0.00	0.02%
	Industrial real-time location systems	0.00	0.04%	0.01	0.02%
Public transportation	Ticket validation	1.10	0.40%	7.16	0.79%
	Reserved seat validation	1.10	0.40%	7.16	0.79%
	Ride sharing (precise positioning)	1.10	0.40%	7.16	0.79%
	Transportation sharing (find a bike or scooter nearby)	1.10	0.40%	7.16	0.79%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Transportation fare payment	1.10	0.40%	7.16	0.79%
Smart building	Physical Access control	1.10	0.40%	7.16	0.79%
	Controlled access	1.10	0.40%	7.16	0.79%
	Employee gathering in emergencies	1.10	0.40%	7.16	0.79%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

South Africa's UWB contribution to GDP is projected to reach approximately USD 5.5 million by 2024. By 2030, that figure is expected to rise significantly to USD 27.6 million, underscoring the strengthening role of UWB in boosting economic output. Cumulatively, from 2022 through 2030, these incremental gains are estimated to exceed USD 113 million, highlighting how sustained adoption of UWB solutions can provide a measurable lift to South Africa's economic landscape (see Graphic 6-25).

Graphic 6-25. South Africa: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

South Africa's UWB deployment is anticipated to yield a steady rise in job creation over the coming years, reflecting the growing demand for specialized expertise in technology deployment, software development, and infrastructure support. By 2024, the number of UWB-related job years is projected to reach 137, increasing to 869 by 2030 as market adoption accelerates. Cumulatively, between 2022 and 2030, the sector is forecast to generate 3,008 job years, underscoring how incremental progress in UWB can translate into tangible labor market benefits across various industries (see Table 6-18).

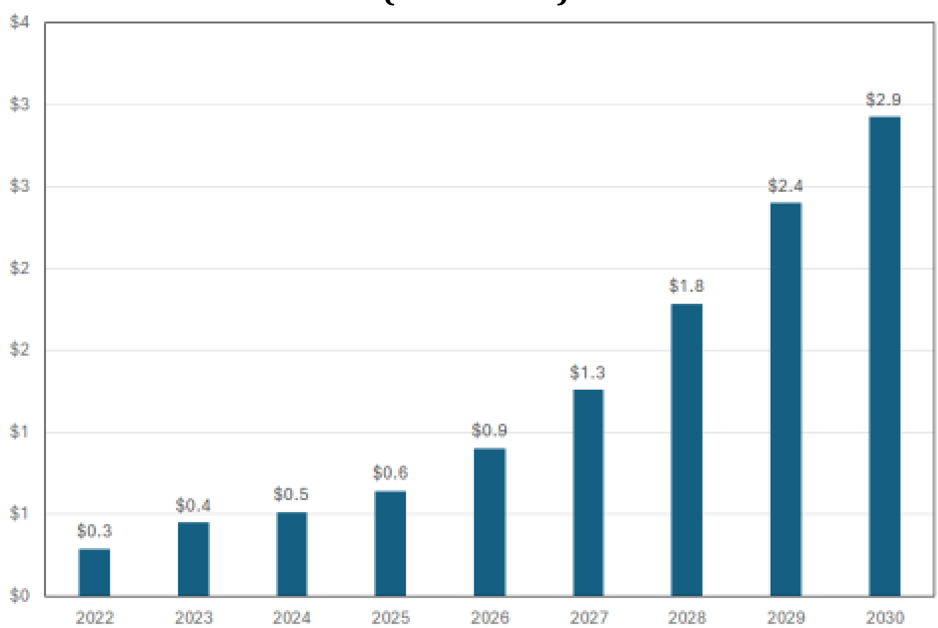
Table 6-18. South Africa: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
103	110	137	180	240	326	457	586	869	3,008

Source: Telecom Advisory Services analysis based on input/output matrix

South Africa's producer surplus from UWB highlights the operational efficiencies gained by enterprises as UWB solutions gradually take root. By 2024, this surplus is estimated to reach around USD 0.5 million, reflecting initial, yet meaningful, improvements in resource allocation and time savings. By 2030, that figure is expected to climb to USD 2.9 million, underscoring the cumulative effect of wider and more sophisticated UWB implementations. From 2022 through 2030, these incremental annual gains are projected to surpass USD 11 million, illustrating UWB's potential to enhance productivity and reduce costs for South African businesses over the long term (see Graphic 6-26).

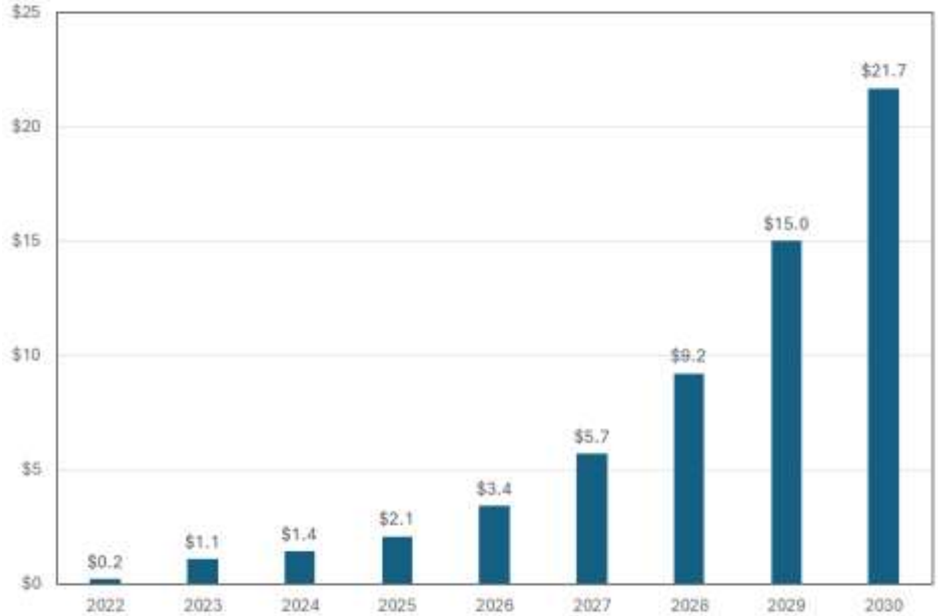
Graphic 6-26. South Africa: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

South Africa's UWB consumer surplus illustrates the growing conveniences that citizens gain through UWB-enabled solutions in everyday life. By 2024, this surplus is anticipated to reach around USD 1.4 million, signaling an early but meaningful integration of UWB technologies at the consumer level. By 2030, the figure is expected to climb to USD 21.7 million, reflecting broader market uptake and an expanded suite of applications. Cumulatively, between 2022 and 2030, these incremental improvements are projected to exceed USD 59 million, underscoring the transformative potential of UWB to enhance personal convenience and efficiency throughout the country (see Graphic 6-27).

Graphic 6-27. South Africa: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In South Africa, the Independent Communications Authority of South Africa (ICASA) is responsible for overseeing the regulatory framework governing UWB operations. Although South Africa does not maintain an extensive UWB-specific set of regulations comparable to those in some regions of Europe or North America, ICASA typically aligns its guidance with internationally recognized standards—particularly regarding allowable power spectral density and operating frequencies in the 3.1–10.6 GHz range[72]. These limits aim to prevent harmful interference with incumbent services, which may include mobile communications, satellite links, and critical radar systems.

Because UWB is primarily introduced as a low-power, short-range technology, local regulators have thus far permitted its deployment on an unlicensed basis, subject to compliance with established emission masks and safety considerations. Equipment manufacturers and service providers must demonstrate adherence to these requirements through conformity assessments and certifications before commercial rollout[73].

6.10. UWB social and economic value in Nigeria

Nigeria's emerging UWB market exhibits a concentrated but potentially impactful uptake of UWB solutions, predominantly in the domains of mobility and consumer applications. For instance, projections for "rider identification in private transport services" and "tap-free mobile payment" both expand from 1.13 million units in 2024 to 13.91 million by 2030,

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[72] Source: https://www.icasa.org.za/legislation-and-regulations/final-regulations/radio-frequency-spectrum-regulations and https://www.icasa.org.za/uploads/files/National-Radio-Frequency-Plan-2021.pdf
[73] Source: https://www.icasa.org.za/legislation-and-regulations/conformity-assessment-framework-for-equipment-authorization

reflecting growing consumer interest in secure, location-based functionalities. Although other areas remain in a nascent stage of adoption, these focal points suggest that Nigeria's UWB landscape could evolve steadily, leveraging wireless precision and real-time data capabilities to enhance everyday transactions and public services (see Table 6-19).

Table 6-19. Nigeria: Units by use case

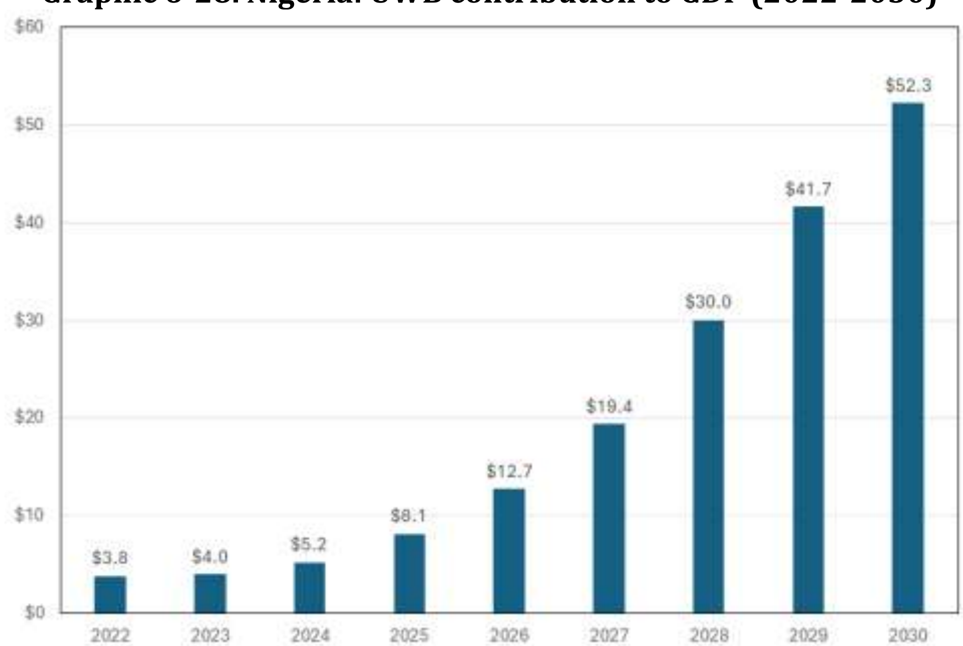
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	1.32	0.41%	15.69	1.54%
	Residential access control	0.03	0.41%	0.80	1.54%
	Easy (logistical) access to personal devices	0.00	0.41%	0.09	1.54%
	All gaming	0.03	0.41%	0.78	1.54%
	Audio streaming	0.00	0.41%	0.13	1.54%
	Gesture-based control	0.03	0.41%	0.80	1.54%
	VR gaming and group play	0.03	0.41%	0.78	1.54%
	Find someone/something nearby	0.13	0.41%	1.89	1.54%
	Smart speaker	0.06	0.41%	0.72	1.54%
	Presence-based device activation	0.00	0.41%	0.22	1.54%
Mobility	Parking garage access control	0.00	0.00%	0.00	0.00%
	Indoor navigation	0.00	0.00%	0.00	0.00%
	Vehicle digital key (car access)	0.00	0.00%	0.00	0.00%
	Rider identification in private transport services	1.13	0.41%	13.91	1.54%
	eID validation in crowded environments	1.13	0.41%	13.91	1.54%
	V2X and autonomous driving	0.00	0.00%	0.00	0.00%
	Driverless valet parking	0.00	0.00%	0.00	0.00%
	EV charging	0.00	0.00%	0.00	0.00%
	Toll collection	0.00	0.00%	0.00	0.00%
	Open trunk with gesture	0.00	0.00%	0.00	0.00%
	In cabin sensing	0.00	0.00%	0.00	0.00%
Individual consumer	Smart watches	0.19	0.41%	1.78	1.54%
	UWB smartphones	1.13	0.41%	13.91	1.54%
Smart retail	Tap-free mobile payment	1.13	0.41%	13.91	1.54%
	Unmanned store access	0.00	0.02%	0.00	0.01%
	Foot traffic and shopping behavior analytics	0.00	0.02%	0.00	0.01%
	Exhibition attendee management	0.00	0.02%	0.00	0.01%
	Targeted marketing	0.00	0.02%	0.00	0.01%
	Drone controlled delivery	0.01	0.02%	0.01	0.01%
	In-vehicle payment	0.00	0.00%	0.00	0.00%
Industrial	Indoor navigation	0.00	0.02%	0.00	0.01%
	Proximity-based patient data sharing	0.00	0.02%	0.00	0.01%
	Teleconference system	0.00	0.02%	0.00	0.01%
	Patient tracking	0.00	0.02%	0.00	0.01%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Industrial real-time location systems	0.00	0.02%	0.00	0.01%
Public transportation	Ticket validation	1.13	0.41%	13.91	1.54%
	Reserved seat validation	1.13	0.41%	13.91	1.54%
	Ride sharing (precise positioning)	1.13	0.41%	13.91	1.54%
	Transportation sharing (find a bike or scooter nearby)	1.13	0.41%	13.91	1.54%
	Transportation fare payment	1.13	0.41%	13.91	1.54%
Smart building	Physical Access control	1.13	0.41%	13.91	1.54%
	Controlled access	1.13	0.41%	13.91	1.54%
	Employee gathering in emergencies	1.13	0.41%	13.91	1.54%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

Nigeria's UWB contribution to GDP is projected to reach approximately USD 5.2 million by 2024, reflecting the early integration of UWB-driven applications. By 2030, this figure is anticipated to surge to USD 52.3 million, underscoring a rapidly expanding market where UWB technology plays an increasingly central role in driving economic output. Taken cumulatively from 2022 through 2030, these annual gains are estimated to surpass USD 177 million, highlighting how incremental growth in UWB adoption can compound into significant macroeconomic benefits for Nigeria over time (see Graphic 6-28).

Graphic 6-28. Nigeria: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

Nigeria's UWB rollout is projected to generate a steady upswing in employment as more industries incorporate UWB-enabled solutions. By 2024, these implementations are expected to create 129 job years, expanding further to 1,654 job years by 2030. Cumulatively, from 2022 through 2030, these labor gains are forecast to reach 4,764 job years, reflecting the accelerating role of UWB in fostering skill demand and operational growth throughout Nigeria's economy (see Table 6-20).

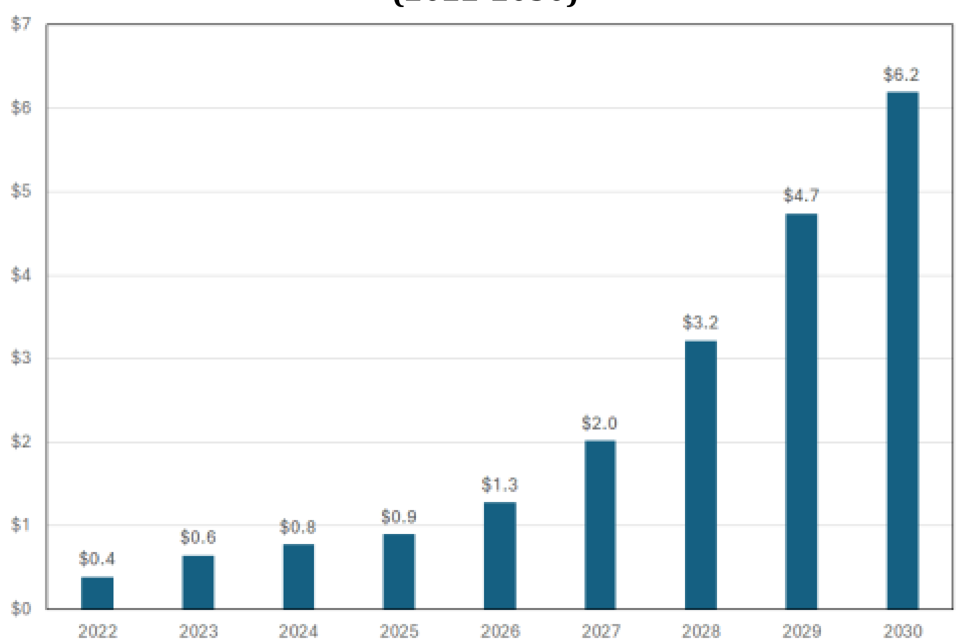
Table 6-20. Nigeria: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
94	100	129	202	316	484	748	1,037	1,654	4,764

Source: Telecom Advisory Services analysis based on input/output matrix

Nigeria's producer surplus from UWB adoption highlights the operational gains enterprises can achieve as UWB-based processes penetrate sectors. By 2024, this surplus is anticipated to reach approximately USD 0.8 million, marking an initial yet notable step toward greater efficiency and cost savings. By 2030, the figure is projected to climb to USD 6.2 million, reflecting broader application of UWB across diverse industries. Cumulatively, over the 2022–2030 period, these annual increments are estimated to total around USD 20 million, underscoring how incremental progress in UWB solutions can yield substantial long-term productivity benefits for Nigerian businesses (see Graphic 6-29).

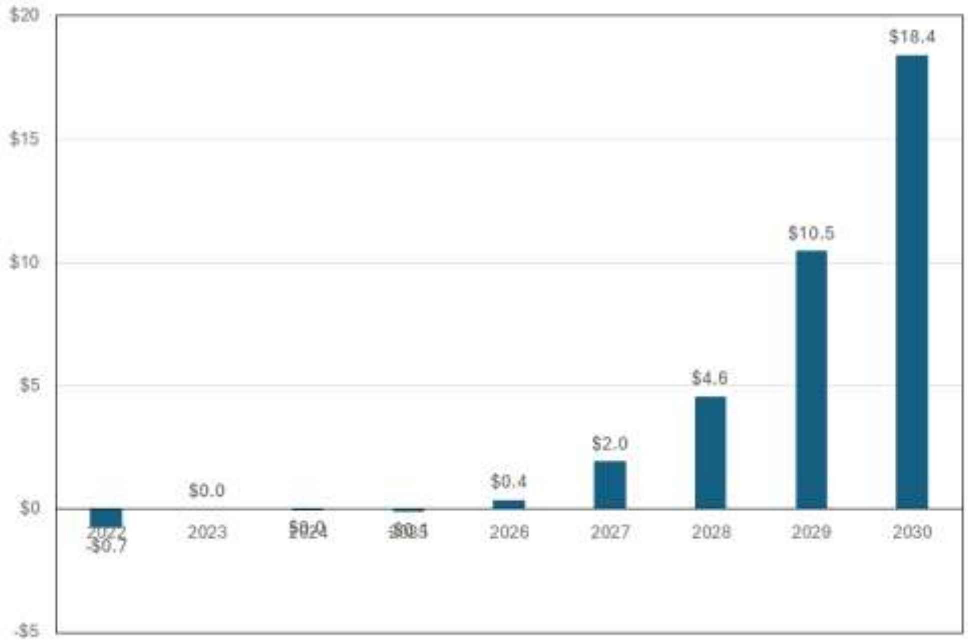
Graphic 6-29. Nigeria: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Nigeria's consumer surplus from UWB starts at negative or near-zero values in the early years, primarily because the model accounts for the upfront costs of acquiring UWB devices before the full benefits takes hold. In 2024, for example, consumers pay for equipment but have not yet experienced sufficient convenience or time savings to outweigh those expenditures. As adoption accelerates and end-users increasingly leverage UWB for tasks like frictionless payments, secure identification, and location-based services, the surplus transitions into positive territory. By 2030, it is projected to reach USD 18.4 million, reflecting a mature stage where the advantages of UWB solutions meaningfully surpass initial investment costs. Cumulatively, over the 2022–2030 period, these annual gains are anticipated to exceed USD 35 million, highlighting the net positive impact for Nigerian consumers once the technology matures (see Graphic 6-30).

Graphic 6-30. Nigeria: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In Nigeria, the Nigerian Communications Commission (NCC) serves as the principal regulator responsible for overseeing UWB technology. While the country does not maintain a highly detailed, UWB-specific regulatory framework akin to those found in certain advanced markets, the NCC generally aligns its guidelines with international standards issued by organizations such as the International Telecommunication Union (ITU). Consequently, UWB operations in Nigeria typically follow emission limits designed to ensure that short-range, low-power transmissions—most commonly within the 3.1–10.6 GHz band—do not interfere with incumbent spectrum users, including commercial mobile services, satellite links, and radar systems.

From a practical standpoint, UWB devices introduced into the Nigerian market are expected to meet technical specifications that cap power spectral density at levels permitting unlicensed operation, yet sufficiently low to avoid harmful interference. Compliance with these emission masks is typically verified through type-approval processes conducted by the NCC, which reviews device documentation to confirm adherence to relevant international guidelines[74]. Additionally, the NCC may impose further constraints on specific UWB applications (e.g., indoor-only use or limited transmission power) if they pose a potential risk to key incumbent services[75].

6.11. UWB social and economic value in the Rest of Africa

The rest of Africa exhibits considerable potential for UWB adoption, particularly in consumer-facing segments such as smart homes and public transportation. For instance, "point and trigger controller app" is anticipated to expand from 5.41 million units in 2024 to 52.53 million by 2030, indicating a strong interest in UWB-enhanced home automation. Meanwhile, applications like "rider identification in private transport services" show a jump from 4.64 million units to 46.57 million over the same period, underscoring the region's appetite for secure, real-time location solutions. These trends illustrate how the rest of Africa is poised for robust growth in UWB uptake across multiple verticals (see Table 6-21).

Table 6-21. Rest of Africa: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	5.41	1.67%	52.53	5.16%
	Residential access control	0.13	1.67%	2.68	5.16%
	Easy (logistical) access to personal devices	0.01	1.67%	0.31	5.16%
	All gaming	0.12	1.67%	2.61	5.16%
	Audio streaming	0.00	1.67%	0.43	5.16%
	Gesture-based control	0.13	1.67%	2.68	5.16%
	VR gaming and group play	0.12	1.67%	2.61	5.16%
	Find someone/something nearby	0.52	1.67%	6.33	5.16%
	Smart speaker	0.26	1.67%	2.40	5.16%
	Presence-based device activation	0.00	1.67%	0.73	5.16%
Mobility	Parking garage access control	0.00	0.02%	0.01	0.01%
	Indoor navigation	0.00	0.02%	0.01	0.01%
	Vehicle digital key (car access)	0.00	0.02%	0.00	0.01%
	Rider identification in private transport services	4.64	1.67%	46.57	5.16%
	eID validation in crowded environments	4.64	1.67%	46.57	5.16%
	V2X and autonomous driving	0.00	0.02%	0.01	0.01%
	Driverless valet parking	0.00	0.02%	0.01	0.01%
	EV charging	0.00	0.02%	0.00	0.01%
	Toll collection	0.00	0.02%	0.01	0.01%
	Open trunk with gesture	0.00	0.02%	0.00	0.01%
	In cabin sensing	0.00	0.02%	0.00	0.01%
	Smart watches	0.77	1.67%	5.96	5.16%

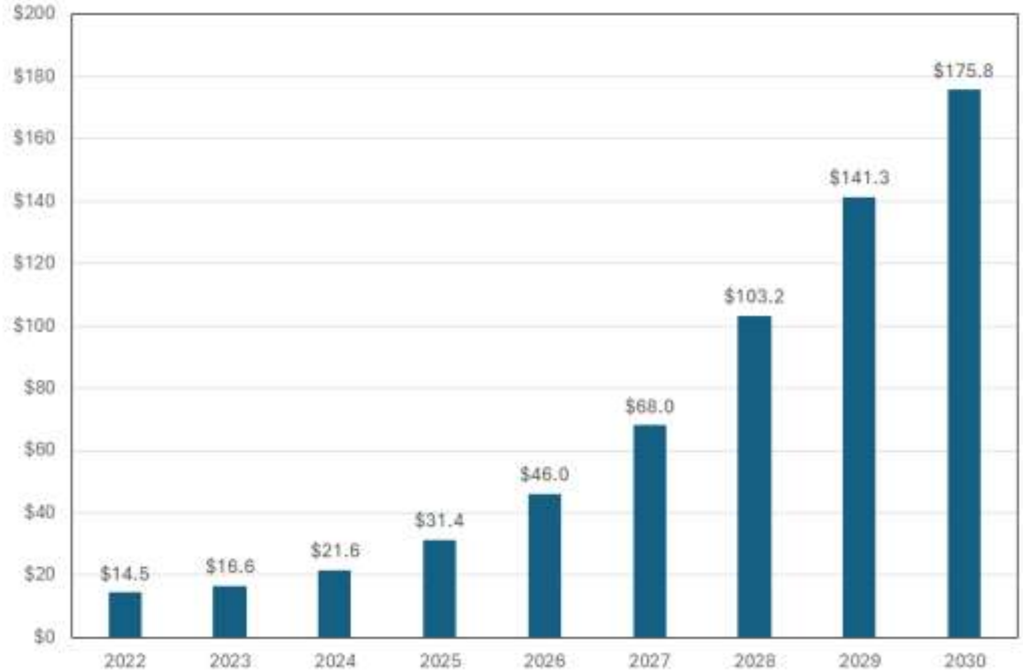
[74] Source: https://ncc.gov.ng/data/misc/Legal_Business_Rules_Type_Approval_Business_Rules_2024.pdf
[75] Source: https://ncc.gov.ng/licensing-regulatory/legal/guidelines

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Individual consumer	UWB smartphones	4.64	1.67%	46.57	5.16%
Smart retail	Tap-free mobile payment	4.64	1.67%	46.57	5.16%
	Unmanned store access	0.01	0.12%	0.02	0.07%
	Foot traffic and shopping behavior analytics	0.01	0.12%	0.02	0.07%
	Exhibition attendee management	0.01	0.12%	0.02	0.07%
	Targeted marketing	0.01	0.12%	0.02	0.07%
	Drone controlled delivery	0.04	0.12%	0.09	0.07%
	In-vehicle payment	0.00	0.02%	0.01	0.01%
Industrial	Indoor navigation	0.01	0.12%	0.02	0.07%
	Proximity-based patient data sharing	0.01	0.12%	0.02	0.07%
	Teleconference system	0.00	0.12%	0.01	0.07%
	Patient tracking	0.01	0.12%	0.02	0.07%
	Industrial real-time location systems	0.01	0.12%	0.02	0.07%
Public transportation	Ticket validation	4.64	1.67%	46.57	5.16%
	Reserved seat validation	4.64	1.67%	46.57	5.16%
	Ride sharing (precise positioning)	4.64	1.67%	46.57	5.16%
	Transportation sharing (find a bike or scooter nearby)	4.64	1.67%	46.57	5.16%
	Transportation fare payment	4.64	1.67%	46.57	5.16%
Smart building	Physical Access control	4.64	1.67%	46.57	5.16%
	Controlled access	4.64	1.67%	46.57	5.16%
	Employee gathering in emergencies	4.64	1.67%	46.57	5.16%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

The rest of Africa's UWB contribution to GDP is projected to reach USD 21.6 million by 2024, reflecting the early yet expanding role of UWB-driven solutions. By 2030, this figure is expected to climb substantially to USD 175.8 million, underscoring the technology's growing economic significance across diverse markets in the region. Cumulatively, between 2022 and 2030, these annual gains are forecast to exceed USD 618 million, illustrating how initial, modest adoption can ultimately translate into a notable uplift for Africa's broader digital economy (see Graphic 6-31).

Graphic 6-31. Rest of Africa: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

The rest of Africa's UWB adoption is projected to generate a steady increase in employment, particularly as more industries integrate UWB solutions for logistics, retail, and public services. By 2024, these activities are estimated to create 539 job years, rising to 5,558 by 2030 as market penetration expands. Cumulatively, between 2022 and 2030, the region is forecast to add 16,585 job years, underscoring how incremental annual growth in UWB utilization can translate into substantial labor market benefits over time (see Table 6-22).

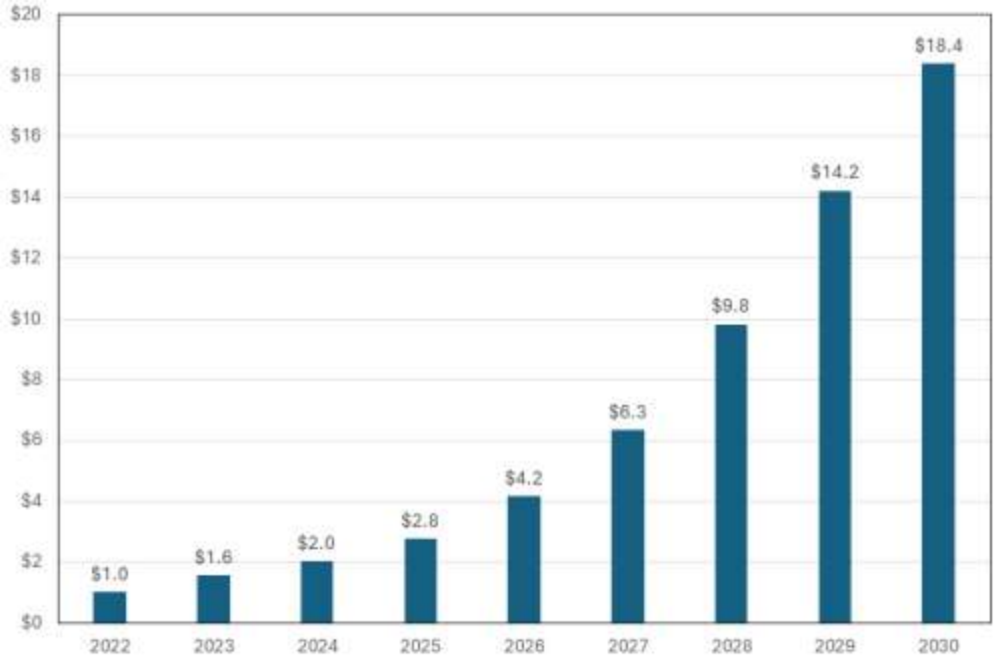
Table 6-22. Rest of Africa: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
358	414	539	782	1,146	1,700	2,570	3,518	5,558	16,585

Source: Telecom Advisory Services analysis based on input/output matrix

The rest of Africa's producer surplus from UWB reflects the potential for operational improvements and cost savings as enterprises increasingly adopt UWB-based processes. By 2024, this surplus is projected to stand at USD 2.0 million, indicating the early-stage benefits achieved through use cases. By 2030, the figure is forecast to rise to USD 18.4 million, underlining the amplified efficiency gains realized once UWB deployments become more extensive and fully integrated. Cumulatively, between 2022 and 2030, these gains are anticipated to exceed USD 60 million, demonstrating how incremental annual progress can ultimately translate into substantial economic advantages across the region (see Graphic 6-32).

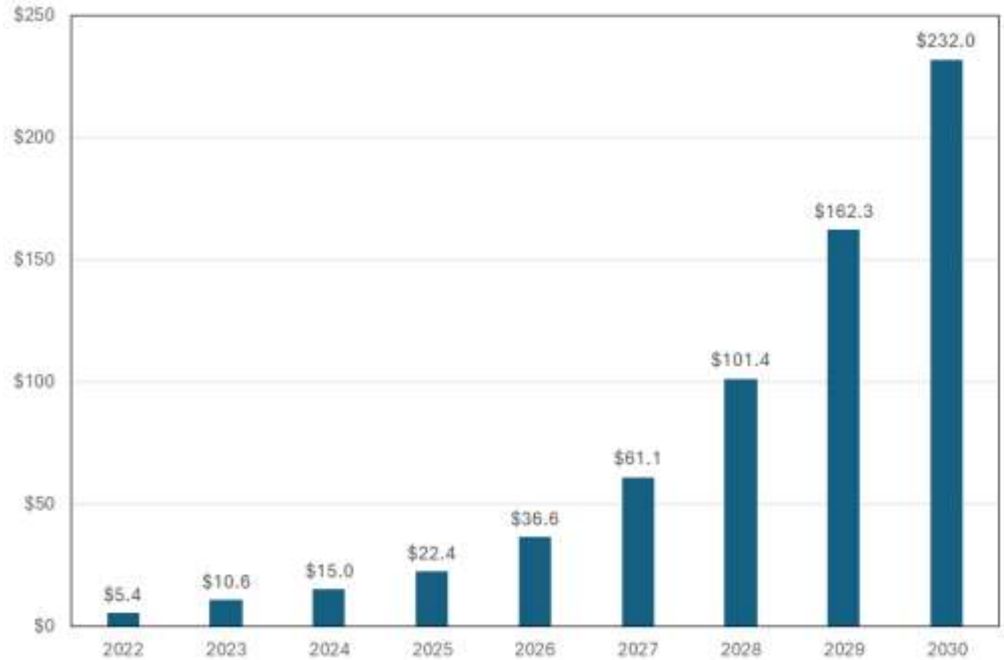
Graphic 6-32. Rest of Africa: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

The rest of Africa's consumer surplus from UWB reflects the growing conveniences that everyday users gain, including faster digital payments and improved location-based services. By 2024, this surplus is forecast to reach around USD 15.0 million, marking the early-stage benefits of UWB adoption for end-users. By 2030, the figure is projected to surge to USD 232.0 million, underscoring a marked expansion of UWB-enabled solutions in daily life. Cumulatively, from 2022 through 2030, these incremental gains are estimated to exceed USD 646 million, highlighting how incremental annual progress ultimately translates into significant advantages for consumers across the region (see Graphic 6-33).

Graphic 6-33. Rest of Africa: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Across much of the African continent (beyond the major markets such as Nigeria and South Africa), UWB technology is generally governed by broad, internationally oriented guidelines rather than highly individualized regulatory frameworks. National telecommunications regulators in these countries frequently align their policies with standards issued by the International Telecommunication Union (ITU), setting emission thresholds within the 3.1–10.6 GHz frequency range to mitigate interference with incumbent services. These incumbent services often include mobile broadband networks, satellite communications, and defense or aeronautical radar systems critical to national infrastructure.

For example, In Kenya, the Communications Authority of Kenya (CA) oversees the regulation of UWB technology. While Kenya does not have specific UWB regulations, the CA aligns its policies with international standards, particularly those set by the International Telecommunication Union (ITU). This alignment ensures that UWB devices operate within the 3.1–10.6 GHz frequency range and adhere to power spectral density limits to prevent interference with existing services such as mobile networks and satellite communications.

Similarly, in Tanzania, the Tanzania Communications Regulatory Authority (TCRA) has established minimum technical specifications for UWB devices. According to TCRA's guidelines, UWB devices are permitted to operate in frequency bands including 2.17 GHz to 10.6 GHz, with specific emission limits to minimize potential interference with other radiocommunication services[76]. These measures are designed to ensure efficient use of UWB technology while protecting incumbent services within the specified bands.

6.12. UWB social and economic value in Japan

Japan's UWB trajectory presents a balanced blend of consumer adoption and industrial implementation, with strong uptake in areas such as mobility and smart building applications. For instance, "tap-free mobile payment" is projected to rise from 16.36 million units in 2024 to 27.05 million by 2030, signaling growing confidence in contactless transactions and secure, location-based functionalities. Meanwhile, categories like "vehicle digital key (car access)" and "physical access control" also show noteworthy progression, illustrating Japan's heightened focus on UWB for streamlined logistics, enhanced security, and optimized workflows (see Table 6-23).

Table 6-23. Japan: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	19.09	5.90%	30.52	3.00%
	Residential access control	0.44	5.90%	1.56	3.00%
	Easy (logistical) access to personal devices	0.03	5.90%	0.18	3.00%
	All gaming	0.42	5.90%	1.52	3.00%
	Audio streaming	0.00	5.90%	0.25	3.00%
	Gesture-based control	0.44	5.90%	1.56	3.00%
	VR gaming and group play	0.42	5.90%	1.52	3.00%
	Find someone/something nearby	1.85	5.90%	3.68	3.00%
	Smart speaker	0.93	5.90%	1.39	3.00%
	Presence-based device activation	0.00	5.90%	0.43	3.00%
Mobility	Parking garage access control	0.33	1.33%	6.97	4.89%
	Indoor navigation	0.33	1.33%	6.97	4.89%
	Vehicle digital key (car access)	0.07	1.33%	1.63	4.89%
	Rider identification in private transport services	16.36	5.90%	27.05	3.00%
	eID validation in crowded environments	16.36	5.90%	27.05	3.00%
	V2X and autonomous driving	0.33	1.33%	6.97	4.89%
	Driverless valet parking	0.33	1.33%	6.97	4.89%
	EV charging	0.10	1.33%	2.19	4.89%
	Toll collection	0.33	1.33%	6.97	4.89%
	Open trunk with gesture	0.01	1.33%	0.22	4.89%
	In cabin sensing	0.02	1.33%	1.47	4.89%
	Smart watches	2.73	5.90%	3.46	3.00%

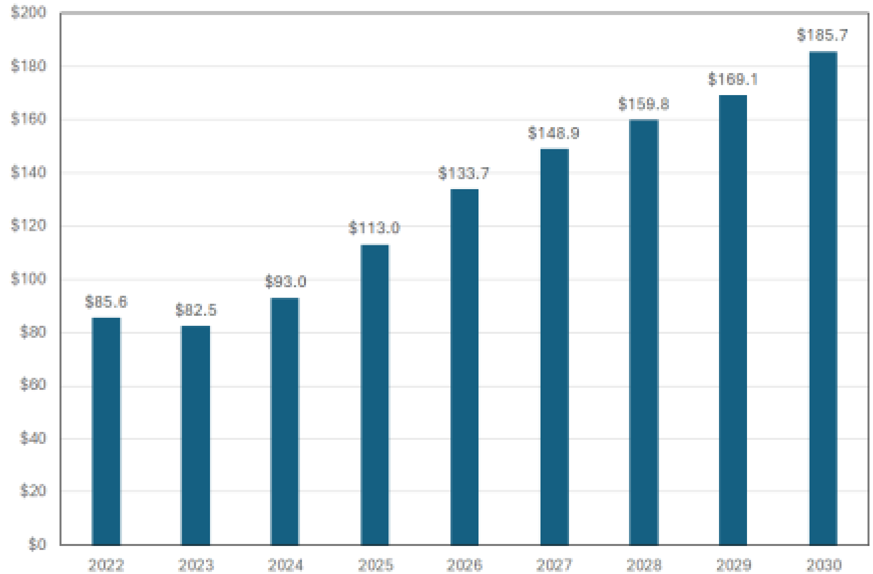
[76] Source: https://tcra.go.tz/uploads/text-editor/files/Minimum%20Technical%20Specifications%20for%20UWB%20%28UWB%29%20Devicespdf_1627025702.pdf

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Individual consumer	UWB smartphones	16.36	5.90%	27.05	3.00%
Smart retail	Tap-free mobile payment	16.36	5.90%	27.05	3.00%
	Unmanned store access	0.16	1.93%	0.53	1.82%
	Foot traffic and shopping behavior analytics	0.16	1.93%	0.53	1.82%
	Exhibition attendee management	0.16	1.93%	0.53	1.82%
	Targeted marketing	0.16	1.93%	0.53	1.82%
	Drone controlled delivery	0.60	1.93%	2.23	1.82%
	In-vehicle payment	0.33	1.33%	6.97	4.89%
Industrial	Indoor navigation	0.16	1.93%	0.53	1.82%
	Proximity-based patient data sharing	0.13	1.93%	0.50	1.82%
	Teleconference system	0.03	1.93%	0.26	1.82%
	Patient tracking	0.13	1.93%	0.50	1.82%
	Industrial real-time location systems	0.16	1.93%	0.53	1.82%
Public transportation	Ticket validation	16.36	5.90%	27.05	3.00%
	Reserved seat validation	16.36	5.90%	27.05	3.00%
	Ride sharing (precise positioning)	16.36	5.90%	27.05	3.00%
	Transportation sharing (find a bike or scooter nearby)	16.36	5.90%	27.05	3.00%
	Transportation fare payment	16.36	5.90%	27.05	3.00%
Smart building	Physical Access control	16.36	5.90%	27.05	3.00%
	Controlled access	16.36	5.90%	27.05	3.00%
	Employee gathering in emergencies	16.36	5.90%	27.05	3.00%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

Japan’s UWB contribution to GDP is projected to reach USD 93.0 million by 2024, reflecting a growing deployment of UWB-driven solutions. By 2030, this figure is anticipated to rise significantly to USD 185.7 million, underscoring the steady maturation of UWB technology across diverse economic fields. Taken cumulatively between 2022 and 2030, these annual gains are estimated to exceed USD 1.1 billion, highlighting the robust impact UWB adoption can have on Japan’s broader economic development (see Graphic 6-34).

Graphic 6-34. Japan: UWB contribution to GDP (2022-2030)



NOTE: Although the number of UWB-enabled units rose from 2022 to 2023, the overall revenue dipped slightly due to scalability effects. As production ramps up, the per-unit cost declines faster than the increase in units sold, resulting in a temporary decrease in total revenue.
Sources: Techno Systems Research; Telecom Advisory Services analysis

Japan's UWB deployment is expected to generate a consistent increase in employment. By 2024, UWB-related activities are estimated to account for 517 job years, expanding to 1,025 by 2030 as adoption accelerates. Cumulatively, between 2022 and 2030, these job additions are projected to total 6,488, underscoring how sustained UWB adoption can drive meaningful labor market growth nationwide (see Table 6-24).

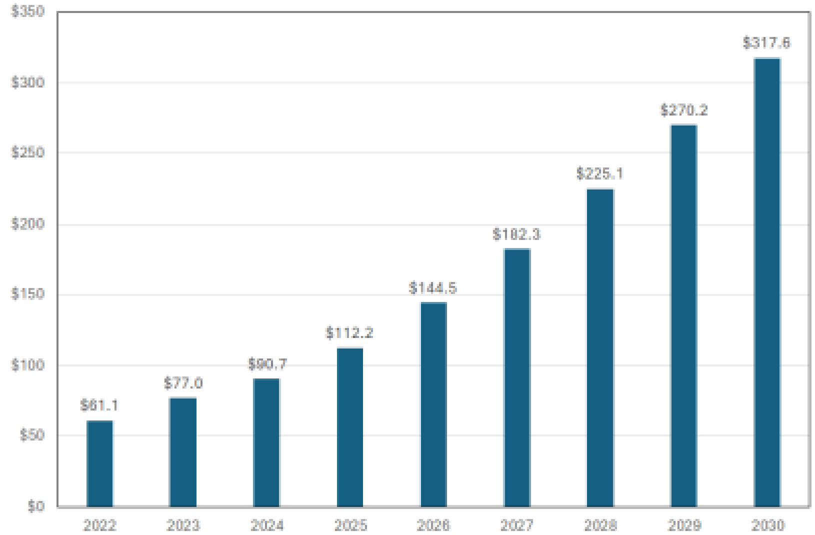
Table 6-24. Japan: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
478	459	517	627	740	823	883	934	1,025	6,488

Source: Telecom Advisory Services analysis based on input/output matrix

Japan's producer surplus from UWB is projected to reach USD 90.7 million by 2024, reflecting initial but tangible efficiency gains. By 2030, this surplus is expected to climb to USD 317.6 million, underlining the deeper operational benefits that emerge as UWB solutions become more widely implemented. Cumulatively, between 2022 and 2030, these incremental enhancements are anticipated to nearly reach USD 1.5 billion, demonstrating UWB's growing capacity to streamline processes and cut costs across multiple Japanese industries (see Graphic 6-35).

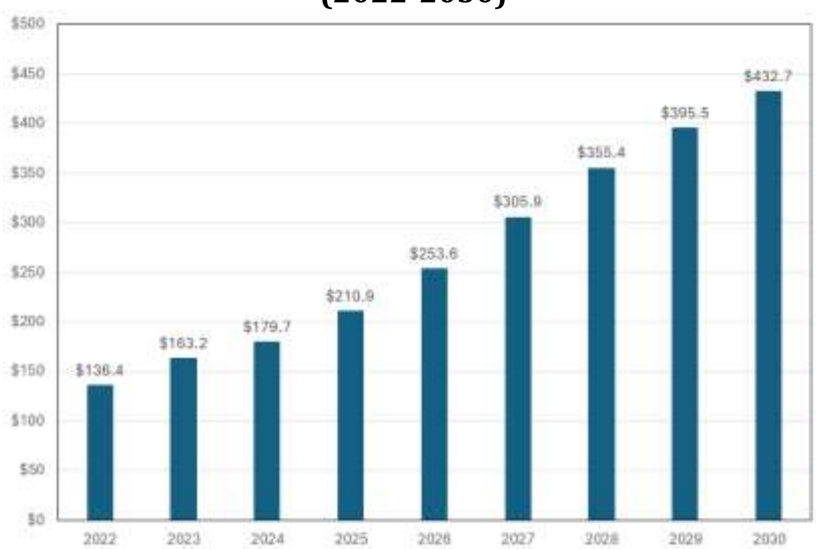
Graphic 6-35. Japan: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Japan's consumer surplus from UWB is expected to reach around USD 179.7 million by 2024, reflecting a growing awareness of UWB-enabled conveniences. By 2030, this figure is projected to climb to USD 432.7 million, underscoring the steady rise in everyday applications that leverage UWB's high-precision capabilities. Cumulatively, between 2022 and 2030, these annual increments are estimated to exceed USD 2.4 billion, highlighting the long-term value UWB can deliver to Japanese consumers through incremental yet substantial improvements in their daily routines (see Graphic 6-36).

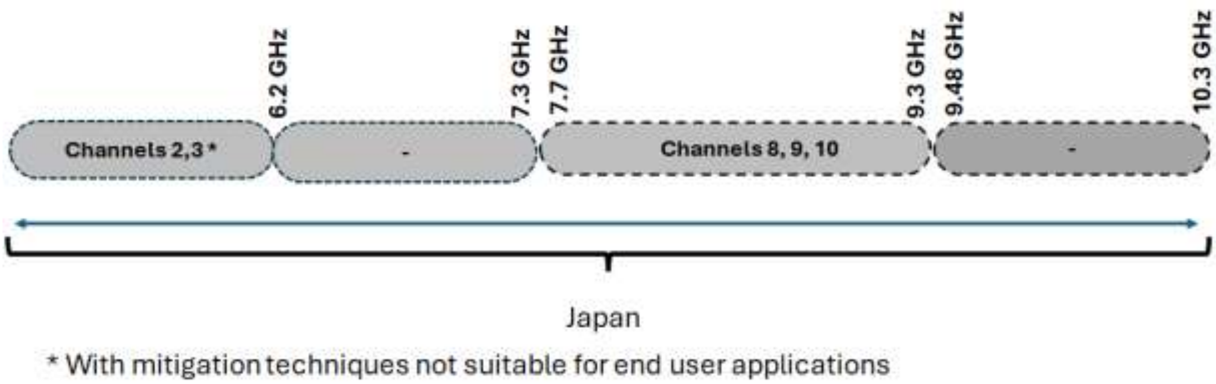
Graphic 6-36. Japan: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In Japan, the Ministry of Internal Affairs and Communications (MIC) assumes primary oversight of the regulatory framework governing UWB. As shown in Figure 6-3, various frequency bands are allocated, subject to specific technical and operational constraints. These allocations aim to protect critical incumbent services—such as land mobile radio, radiolocation, and satellite communications—while enabling UWB-based applications for both indoor and outdoor use, including data communication and automotive radar systems.

Figure 6-3. Japan: UWB spectrum allocation



Source: FiRA Consortium

In Japan, the frequency band from 3.4–4.8 GHz operates under a power spectral density (PSD) limit of −41.3-41.3−41.3 dBm/MHz, designated for land mobile radio services and indoor data communication only. Dynamic Frequency Selection (DAA) is mandatory in this band to mitigate potential interference. The 7.25–10.25 GHz band is also allocated at the same PSD limit of −41.3-41.3−41.3 dBm/MHz, serving various applications, including indoor and outdoor land mobile radio services, data communication, and radiolocation. However, the band spanning 7.587–8.4 GHz has specific subdivisions: from 7.587–7.662 GHz, the PSD limit is stricter at −51.3-51.3−51.3 dBm/MHz, while 7.662–8.4 GHz operates at −41.3-41.3−41.3 dBm/MHz. Both segments support land mobile radio services and data communication for indoor and outdoor environments, offering flexibility while ensuring minimal interference.

The broader band from 7.25–9.0 GHz, also capped at −41.3-41.3−41.3 dBm/MHz, accommodates land mobile radio services, sensing, radiolocation, and data communication for both indoor and outdoor use. However, devices operating in this band must avoid causing harmful interference to incumbent systems, such as Satellite Remote Sensing (SRS) earth stations, Radio Astronomy Services (RAS), Radiolocation Services (RLS), and Radio Navigation Satellite Services (RNS). Finally, the frequency band from 24.25–29.0 GHz is allocated with a PSD limit of −41.3-41.3−41.3 dBm/MHz specifically for automotive short-range radar (SRR) systems. These allocations, governed by the Ordinance for Regulating Radio Equipment, balance regulatory constraints and innovative UWB applications, ensuring coexistence with critical incumbent services across Japan.

6.13. UWB social and economic value in South Korea

South Korea's UWB market displays a robust expansion across both consumer-centric and enterprise use cases. In particular, "point and trigger controller app" is anticipated to increase from 11.65 million units in 2024 to 19.33 million by 2030, highlighting the rising demand for seamless smart home controls. Meanwhile, "rider identification in private transport services" shows significant growth from 9.98 million units to 17.13 million, emphasizing the emphasis on secure, location-aware functionalities in mobility and public services. These trends underscore South Korea's evolving reliance on UWB, spanning everything from everyday consumer conveniences to advanced industrial and infrastructure applications (see Table 6-25).

Table 6-25. South Korea: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	11.65	3.60%	19.33	1.90%
	Residential access control	0.27	3.60%	0.99	1.90%
	Easy (logistical) access to personal devices	0.02	3.60%	0.11	1.90%
	All gaming	0.25	3.60%	0.96	1.90%
	Audio streaming	0.00	3.60%	0.16	1.90%
	Gesture-based control	0.27	3.60%	0.99	1.90%
	VR gaming and group play	0.25	3.60%	0.96	1.90%
	Find someone/something nearby	1.13	3.60%	2.33	1.90%
	Smart speaker	0.57	3.60%	0.88	1.90%
	Presence-based device activation	0.00	3.60%	0.27	1.90%
Mobility	Parking garage access control	0.15	0.60%	0.28	0.20%
	Indoor navigation	0.15	0.60%	0.28	0.20%
	Vehicle digital key (car access)	0.03	0.60%	0.07	0.20%
	Rider identification in private transport services	9.98	3.60%	17.13	1.90%
	eID validation in crowded environments	9.98	3.60%	17.13	1.90%
	V2X and autonomous driving	0.15	0.60%	0.28	0.20%
	Driverless valet parking	0.15	0.60%	0.28	0.20%
	EV charging	0.05	0.60%	0.09	0.20%
	Toll collection	0.15	0.60%	0.28	0.20%
	Open trunk with gesture	0.00	0.60%	0.01	0.20%
	In cabin sensing	0.01	0.60%	0.06	0.20%
Individual consumer	Smart watches	1.67	3.60%	2.19	1.90%
	UWB smartphones	9.98	3.60%	17.13	1.90%
Smart retail	Tap-free mobile payment	9.98	3.60%	17.13	1.90%
	Unmanned store access	0.07	0.88%	0.24	0.82%
	Foot traffic and shopping behavior analytics	0.07	0.88%	0.24	0.82%
	Exhibition attendee management	0.07	0.88%	0.24	0.82%
	Targeted marketing	0.07	0.88%	0.24	0.82%
	Drone controlled delivery	0.28	0.88%	1.01	0.82%
	In-vehicle payment	0.15	0.60%	0.28	0.20%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Industrial	Indoor navigation	0.07	0.88%	0.24	0.82%
	Proximity-based patient data sharing	0.06	0.88%	0.23	0.82%
	Teleconference system	0.01	0.88%	0.12	0.82%
	Patient tracking	0.06	0.88%	0.23	0.82%
	Industrial real-time location systems	0.07	0.88%	0.24	0.82%
Public transportation	Ticket validation	9.98	3.60%	17.13	1.90%
	Reserved seat validation	9.98	3.60%	17.13	1.90%
	Ride sharing (precise positioning)	9.98	3.60%	17.13	1.90%
	Transportation sharing (find a bike or scooter nearby)	9.98	3.60%	17.13	1.90%
	Transportation fare payment	9.98	3.60%	17.13	1.90%
Smart building	Physical Access control	9.98	3.60%	17.13	1.90%
	Controlled access	9.98	3.60%	17.13	1.90%
	Employee gathering in emergencies	9.98	3.60%	17.13	1.90%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

South Korea's UWB contribution to GDP is projected to reach USD 53.6 million by 2024, signaling a notable expansion of UWB deployments. By 2030, that figure is expected to climb to USD 84.8 million, reflecting the continued evolution and integration of UWB solutions across multiple industries. Cumulatively, from 2022 through 2030, these annual increments are estimated to exceed USD 609 million, underscoring UWB's sustained potential to boost South Korea's economic output as adoption grows (see Graphic 6-37).

Graphic 6-37. South Korea: UWB contribution to GDP (2022-2030)

Sources: Techno Systems Research; Telecom Advisory Services analysis

South Korea's UWB adoption is expected to generate a moderate but continuous increase in job creation across multiple technological and service-oriented roles. By 2024, job years attributed to UWB are forecast to reach 298, rising further to 469 by 2030. Over the entire period from 2022 to 2030, these gains are projected to total 3,377 job years, underscoring how incremental annual progress in UWB integration can translate into a substantial, long-term impact on South Korea's labor market (see Table 6-26).

Table 6-26. South Korea: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
240	248	298	386	424	431	438	443	469	3,377

Source: Telecom Advisory Services analysis based on input/output matrix

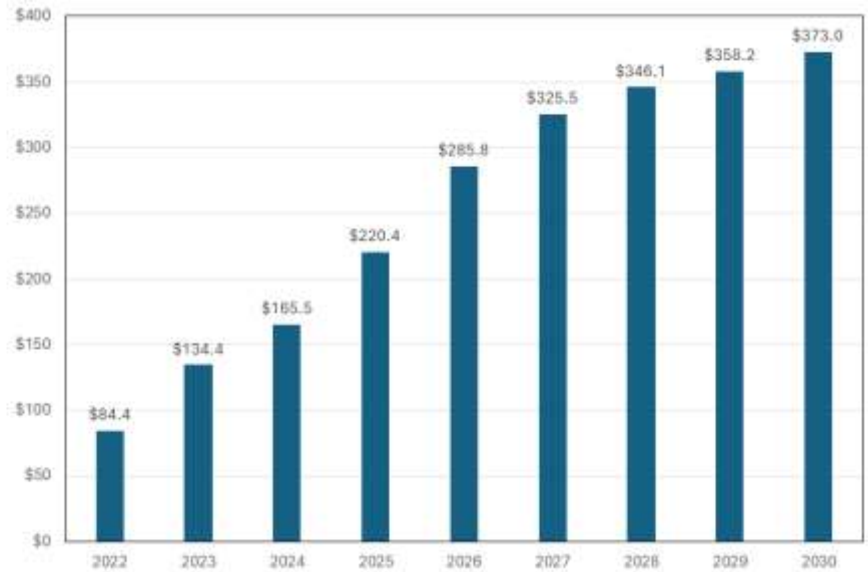
South Korea's UWB producer surplus is forecast to reach USD 88.9 million by 2024, highlighting early efficiency gains in several sectors. By 2030, this surplus is projected to climb to USD 279.6 million, reflecting a more mature stage of UWB adoption and deeper integration of location-precise and automated workflows. Cumulatively, between 2022 and 2030, these incremental improvements are anticipated to exceed USD 1.3 billion, underscoring how sustained UWB implementation can yield considerable productivity benefits for enterprises nationwide (see Graphic 6-38).

Graphic 6-38. South Korea: UWB contribution to producer surplus (2022-2030)

Sources: Telecom Advisory Services analysis

South Korea's consumer surplus from UWB is anticipated to reach approximately USD 165.5 million by 2024, illustrating the early yet meaningful benefits that UWB-enabled services offer in daily. By 2030, this figure is projected to climb to USD 373.0 million, reflecting a more mature stage of adoption driven by broader and deeper implementation of UWB solutions. Cumulatively, from 2022 through 2030, these annual increments are estimated to exceed USD 2.2 billion, underscoring how steady gains each year can translate into a substantial long-term boost to consumer welfare in South Korea's digital landscape (see Graphic 6-39).

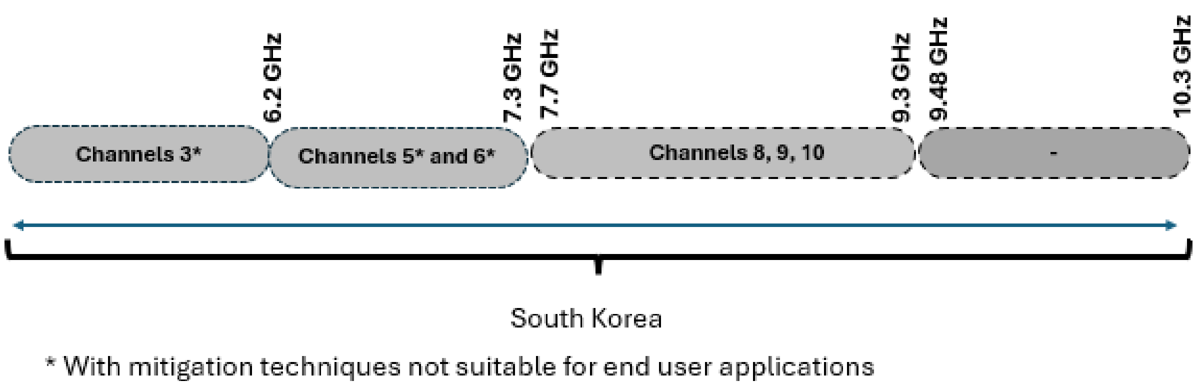
Graphic 6-39. South Korea: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In South Korea, the regulation of UWB falls primarily under the purview of the Ministry of Science and ICT (MSIT) and the Korea Communications Commission (KCC). As illustrated in Figure 6-4 the allocation of UWB spectrum, divided into multiple channels—most notably Channels 3, 5, 6, 8, 9, and 10. Each channel occupies a specific portion of the frequency range, and some require mitigation techniques that are generally unsuitable for end-user applications. By segmenting the UWB spectrum into these dedicated channels, South Korean regulators seek to balance the growing demands for wireless innovation with the need to protect incumbent services. This ensures that low-power, short-range UWB transmissions can coexist alongside licensed systems—including mobile communications and radar—without causing harmful interference.

Figure 6-4. South Korea: UWB spectrum allocation



Source: FiRA Consortium

According to the Technical Standards of Wireless Equipment for Unlicensed Wireless Radio Stations (MSIT notice 2022-75), the 4.2–4.8 GHz band in the Republic of Korea is allocated for UWB usage with a power spectral density (PSD) limit of −41.3-41.3−41.3 dBm/MHz. Devices operating in this range must implement either Dynamic Frequency Selection (DAA) or Low Duty Cycle (LDC) mechanisms to minimize the risk of interfering with incumbent services. These measures help ensure that UWB's low-power, short-range communications remain compatible with existing wireless systems.

In addition, frequencies spanning 6.0–10.2 GHz are also governed by a −41.3-41.3−41.3 dBm/MHz PSD limit. However, within the 6.0–7.2 GHz portion, LDC operation is specifically required, and fixed outdoor installations are not permitted. Meanwhile, the 6.0–8.8 GHz segment is available for mobile device use, offering expanded capacity for UWB-based applications such as precision tracking and data communication. By enforcing these technical constraints, South Korean regulators balance the need for innovation in UWB technologies with the obligation to protect incumbent services from potential interference.

6.14. UWB social and economic value in China

China's UWB ecosystem showcases a large-scale adoption across multiple domains, ranging from consumer applications to advanced industrial solutions. For instance, "point and trigger controller app" usage is anticipated to grow from 62.46 million units in 2024 to 275.69 million by 2030, underscoring strong interest in seamless smart home functionalities. Meanwhile, "tap-free mobile payment" is projected to jump from 53.52 million to 244.39 million over the same period, highlighting China's vast market for secure, high-speed transactions. These trends also extend to public transportation—evident in "ticket validation" and "ride sharing"—demonstrating how UWB is poised to shape everyday activities, industrial processes, and infrastructure on an impressive scale (see Table 6-27).

Table 6-27. China: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	62.46	19.30%	275.69	27.10%
	Residential access control	1.45	19.30%	14.09	27.10%
	Easy (logistical) access to personal devices	0.10	19.30%	1.63	27.10%
	All gaming	1.37	19.30%	13.72	27.10%
	Audio streaming	0.00	19.30%	2.28	27.10%
	Gesture-based control	1.45	19.30%	14.09	27.10%
	VR gaming and group play	1.37	19.30%	13.72	27.10%
	Find someone/something nearby	6.04	19.30%	33.20	27.10%
	Smart speaker	3.06	19.30%	12.60	27.10%
	Presence-based device activation	0.00	19.30%	3.84	27.10%
Mobility	Parking garage access control	7.28	29.24%	52.11	36.58%
	Indoor navigation	7.28	29.24%	52.11	36.58%

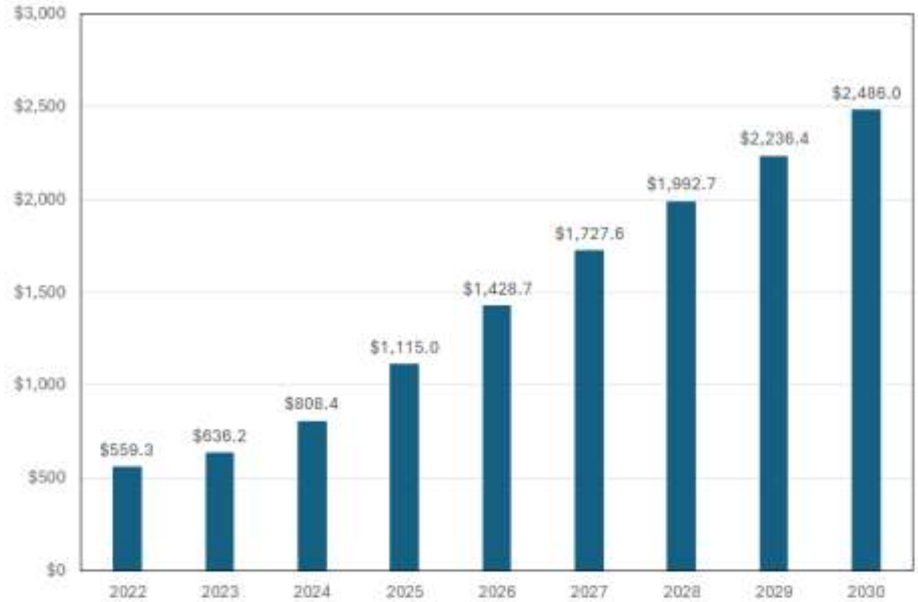
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Vehicle digital key (car access)	1.49	29.24%	12.20	36.58%
	Rider identification in private transport services	53.52	19.30%	244.39	27.10%
	eID validation in crowded environments	53.52	19.30%	244.39	27.10%
	V2X and autonomous driving	7.28	29.24%	52.11	36.58%
	Driverless valet parking	7.28	29.24%	52.11	36.58%
	EV charging	2.28	29.24%	16.37	36.58%
	Toll collection	7.28	29.24%	52.11	36.58%
	Open trunk with gesture	0.21	29.24%	1.67	36.58%
	In cabin sensing	0.52	29.24%	10.96	36.58%
Individual consumer	Smart watches	8.94	19.30%	31.30	27.10%
	UWB smartphones	53.52	19.30%	244.39	27.10%
Smart retail	Tap-free mobile payment	53.52	19.30%	244.39	27.10%
	Unmanned store access	4.57	54.50%	15.93	54.25%
	Foot traffic and shopping behavior analytics	4.57	54.50%	15.93	54.25%
	Exhibition attendee management	4.57	54.50%	15.93	54.25%
	Targeted marketing	4.57	54.50%	15.93	54.25%
	Drone controlled delivery	17.05	54.50%	66.47	54.25%
	In-vehicle payment	7.28	29.24%	52.11	36.58%
Industrial	Indoor navigation	4.57	54.50%	15.93	54.25%
	Proximity-based patient data sharing	3.63	54.50%	14.86	54.25%
	Teleconference system	0.87	54.50%	7.72	54.25%
	Patient tracking	3.63	54.50%	14.86	54.25%
	Industrial real-time location systems	4.57	54.50%	15.93	54.25%
Public transportation	Ticket validation	53.52	19.30%	244.39	27.10%
	Reserved seat validation	53.52	19.30%	244.39	27.10%
	Ride sharing (precise positioning)	53.52	19.30%	244.39	27.10%
	Transportation sharing (find a bike or scooter nearby)	53.52	19.30%	244.39	27.10%
	Transportation fare payment	53.52	19.30%	244.39	27.10%
Smart building	Physical Access control	53.52	19.30%	244.39	27.10%
	Controlled access	53.52	19.30%	244.39	27.10%
	Employee gathering in emergencies	53.52	19.30%	244.39	27.10%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

China's UWB contribution to GDP is expected to reach approximately USD 808.4 million by 2024, underscoring the country's rapid deployment of UWB-driven applications across consumer, industrial, and infrastructure domains. By 2030, this figure is projected to rise dramatically to USD 2,486.0 million, reflecting the deepening penetration of UWB solutions and the scale of China's digital economy. From 2022 to 2030, the cumulative impact of these annual increments is estimated to nearly reach USD 13.0 billion, highlighting how sustained

UWB adoption can significantly boost the nation's overall economic output (see Graphic 6-40).

Graphic 6-40. China: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

China's UWB deployment is forecast to generate a substantial uplift in employment, reflecting the vast market potential for UWB solutions. By 2024, UWB-related job years are expected to reach 8,228, rising further to 25,303 by 2030 as adoption accelerates. Cumulatively, over the 2022–2030 period, these gains are projected to total 132,216 job years, underscoring the considerable impact that sustained UWB implementation could have on China's labor market (see Table 6-28).

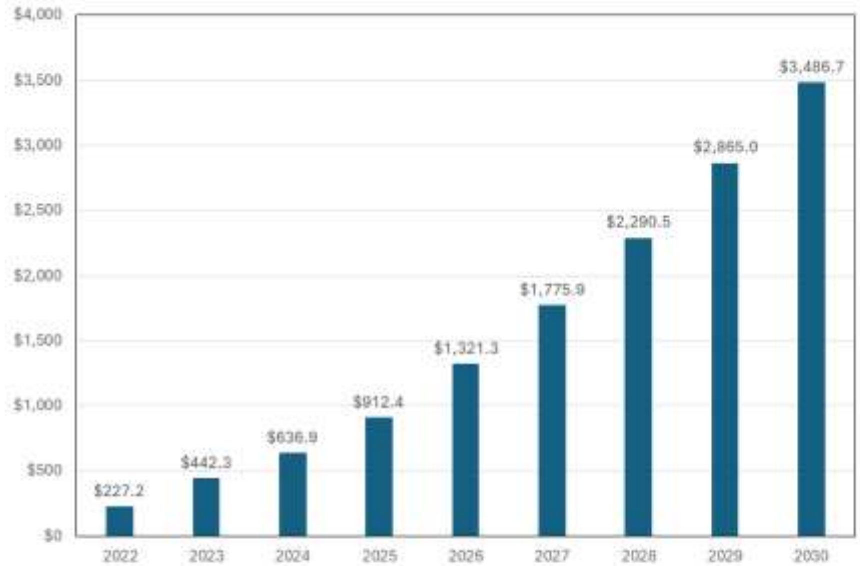
Table 6-28. China: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
5,692	6,475	8,228	11,348	14,542	17,584	20,282	22,762	25,303	132,216

Source: Telecom Advisory Services analysis based on input/output matrix

China's producer surplus from UWB is projected to reach around USD 636.9 million by 2024, reflecting the initial efficiency gains ion of UWB-based processes and workflows across multiple sectors. Cumulatively, between 2022 and 2030, these annual increments are estimated to reach nearly USD 14.0 billion, underscoring the sizeable impact that sustained UWB adoption can have on operational improvements and cost savings nationwide (see Graphic 6-41).

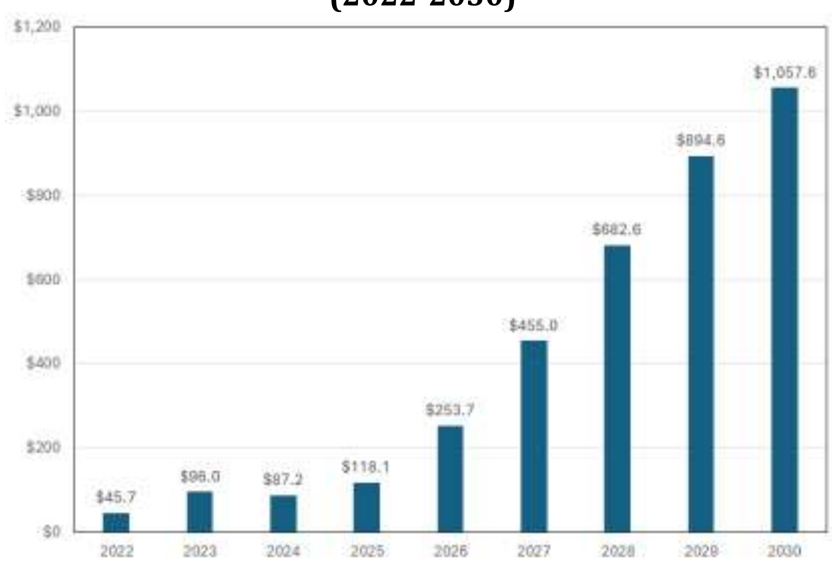
Graphic 6-41. China: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

China's consumer surplus from UWB is anticipated to reach approximately USD 87.2 million by 2024, indicating the early yet meaningful advantages UWB brings to daily life. By 2030, this figure is projected to climb to USD 1,057.6 million, reflecting more extensive integration of UWB capabilities in everything from home automation to public transportation. Over the 2022–2030 period, these annual increments are estimated to exceed USD 3.6 billion cumulatively, underscoring how continuous advancements in UWB technology can significantly enhance consumer experiences in China's ever-evolving digital landscape (see Graphic 6-42).

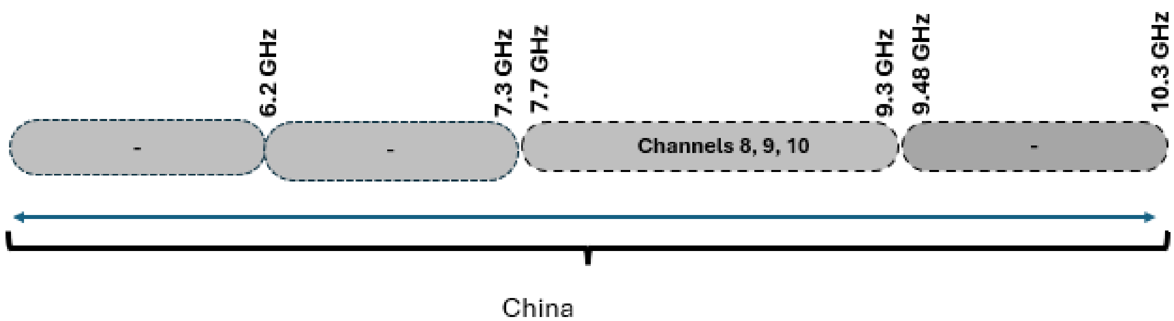
Graphic 6-42. China: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In China, UWB oversight primarily falls under the authority of the Ministry of Industry and Information Technology (MIIT). As shown in Figure 6-5 only certain portions of this range are actively allocated for practical applications. For instance, only channels 8, 9, and 10—spanning frequencies around 7.7 GHz, 9.3 GHz. Much like in other regions, China's UWB framework is designed to ensure that short-range, low-power UWB transmissions do not interfere with licensed services, such as radar and mobile communications, while still enabling the development of UWB-based devices and applications.

Figure 6-5. China: UWB spectrum allocation



Source: FiRA Consortium

According to MIIT Wireless File 354 (2008), China's UWB regulations stipulate a −41-41−41 dBm/MHz power spectral density limit across three key frequency ranges: up to 1.6 GHz, from 1.6–10.6 GHz, and above 10.6 GHz. In practice, the band from 6.0–9.0 GHz is specifically highlighted for UWB operations under the −41-41−41 dBm/MHz threshold, while frequencies between 4.2–4.8 GHz require additional interference mitigation techniques to safeguard incumbent users. Although a formal decision regarding allocation has been made, China's regulatory framework may be subject to revisions if newer documentation is issued by the Ministry of Industry and Information Technology (MIIT). This iterative approach allows regulators to maintain spectrum harmony while accommodating technological advances in UWB.

6.15. UWB social and economic value in the rest of Asia Pacific

The rest of the Asia Pacific region is set to see considerable UWB adoption spanning both consumer-driven solutions and enterprise-focused implementations. For example, "point and trigger controller app" usage is anticipated to climb from 39.02 million units in 2024 to 203.03 million by 2030, illustrating a rising demand for seamless smart home controls. Meanwhile, "rider identification in private transport services" and "tap-free mobile payment" both show significant growth from 33.43 million to 179.98 million, highlighting the region's eagerness for precise, secure, and efficient UWB applications. As outlined below, these trends signal how various sectors—from mobility to retail—are increasingly incorporating UWB to enhance convenience, productivity, and overall user experiences (see Table 6-29).

Table 6-29. Rest of Asia Pacific: Units by use case

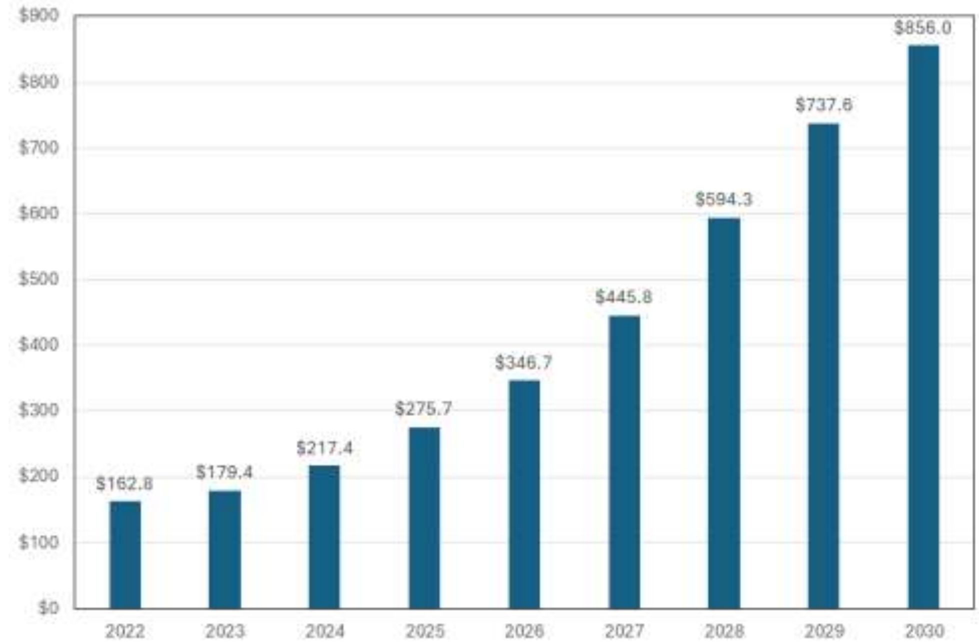
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	39.02	12.06%	203.03	19.96%
	Residential access control	0.90	12.06%	10.38	19.96%
	Easy (logistical) access to personal devices	0.06	12.06%	1.20	19.96%
	All gaming	0.85	12.06%	10.10	19.96%
	Audio streaming	0.00	12.06%	1.68	19.96%
	Gesture-based control	0.90	12.06%	10.38	19.96%
	VR gaming and group play	0.85	12.06%	10.10	19.96%
	Find someone/something nearby	3.77	12.06%	24.45	19.96%
	Smart speaker	1.91	12.06%	9.28	19.96%
	Presence-based device activation	0.00	12.06%	2.83	19.96%
Mobility	Parking garage access control	0.83	3.35%	1.55	1.09%
	Indoor navigation	0.83	3.35%	1.55	1.09%
	Vehicle digital key (car access)	0.17	3.35%	0.36	1.09%
	Rider identification in private transport services	33.43	12.06%	179.98	19.96%
	eID validation in crowded environments	33.43	12.06%	179.98	19.96%
	V2X and autonomous driving	0.83	3.35%	1.55	1.09%
	Driverless valet parking	0.83	3.35%	1.55	1.09%
	EV charging	0.26	3.35%	0.49	1.09%
	Toll collection	0.83	3.35%	1.55	1.09%
	Open trunk with gesture	0.02	3.35%	0.05	1.09%
	In cabin sensing	0.06	3.35%	0.33	1.09%
Individual consumer	Smart watches	5.58	12.06%	23.05	19.96%
	UWB smartphones	33.43	12.06%	179.98	19.96%
Smart retail	Tap-free mobile payment	33.43	12.06%	179.98	19.96%
	Unmanned store access	0.56	6.69%	2.21	7.51%
	Foot traffic and shopping behavior analytics	0.56	6.69%	2.21	7.51%
	Exhibition attendee management	0.56	6.69%	2.21	7.51%
	Targeted marketing	0.56	6.69%	2.21	7.51%
	Drone controlled delivery	2.09	6.69%	9.20	7.51%
	In-vehicle payment	0.83	3.35%	1.55	1.09%
Industrial	Indoor navigation	0.56	6.69%	2.21	7.51%
	Proximity-based patient data sharing	0.45	6.69%	2.06	7.51%
	Teleconference system	0.11	6.69%	1.07	7.51%
	Patient tracking	0.45	6.69%	2.06	7.51%
	Industrial real-time location systems	0.56	6.69%	2.21	7.51%
Public transportation	Ticket validation	33.43	12.06%	179.98	19.96%
	Reserved seat validation	33.43	12.06%	179.98	19.96%
	Ride sharing (precise positioning)	33.43	12.06%	179.98	19.96%
	Transportation sharing (find a bike or scooter nearby)	33.43	12.06%	179.98	19.96%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Transportation fare payment	33.43	12.06%	179.98	19.96%
Smart building	Physical Access control	33.43	12.06%	179.98	19.96%
	Controlled access	33.43	12.06%	179.98	19.96%
	Employee gathering in emergencies	33.43	12.06%	179.98	19.96%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

The rest of Asia Pacific's UWB contribution to GDP is projected to reach approximately USD 217.4 million by 2024, reflecting expanding UWB deployments in several segments. By 2030, this figure is forecast to climb to USD 856.0 million, underscoring the technology's strengthening economic role across a wide array of services and applications. Cumulatively, from 2022 to 2030, these annual increments are estimated to exceed USD 3.8 billion, highlighting how incremental gains in UWB adoption can substantially uplift the region's digital economy over time (see Graphic 6-43).

Graphic 6-43. Rest of Asia Pacific: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

The rest of Asia Pacific is expected to experience a gradual yet steady rise in UWB-driven job creation, as both consumer and enterprise sectors increasingly incorporate UWB solutions. By 2024, these activities are projected to generate approximately 1,208 job years, growing to nearly 4,727 job years by 2030. When considering the entire 2022–2030 interval, these expansions amount to 21,119 job years, underscoring the sustained impact that annual gains in UWB adoption can have on the region's labor market (see Table 6-30).

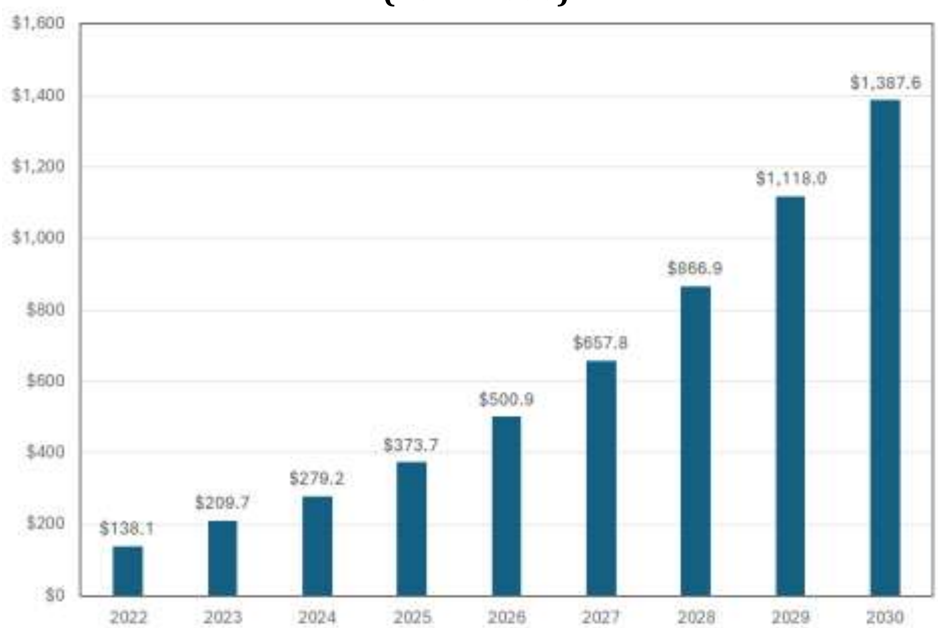
Table 6-30. Rest of Asia Pacific: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
910	999	1,208	1,530	1,920	2,465	3,286	4,074	4,727	21,119

Source: Telecom Advisory Services analysis based on input/output matrix

The rest of Asia Pacific's producer surplus from UWB is projected to reach approximately USD 279.2 million by 2024, reflecting early yet tangible efficiency gains in several sectors. By 2030, this figure is anticipated to climb to USD 1,387.6 million, signaling a more mature phase of UWB adoption throughout diverse market segments. Cumulatively, over the 2022–2030 period, these incremental gains are estimated to reach nearly USD 5.5 billion, underscoring the substantial impact UWB can have on streamlining operations and reducing costs across the region (see Graphic 6-44).

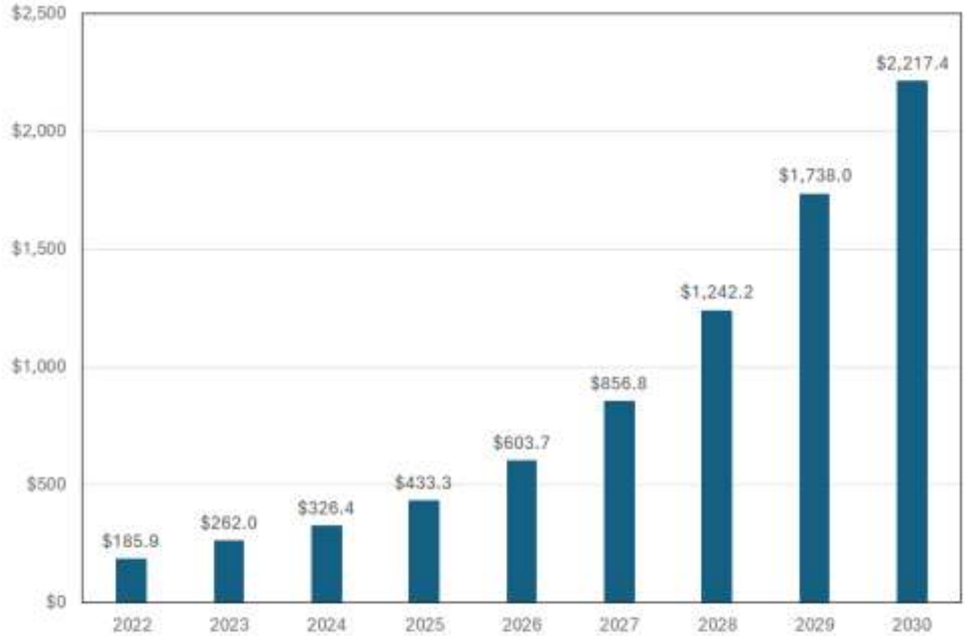
Graphic 6-44. Rest of Asia Pacific: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

The rest of Asia Pacific's consumer surplus from UWB is expected to reach around USD 326.4 million by 2024, reflecting the early benefits that UWB-enabled services bring to daily life in sectors such as retail, mobility, and smart homes. By 2030, this figure is projected to rise significantly to USD 2,217.4 million, indicating widespread integration of UWB across more diverse applications. Cumulatively, between 2022 and 2030, these incremental annual gains are estimated to surpass USD 7.8 billion, highlighting how consistent adoption of UWB technology can substantially enhance consumer experiences and convenience over time (see Graphic 6-45).

Graphic 6-45. Rest of Asia Pacific: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Throughout much of the remaining Asia Pacific region, UWB technology is governed by a patchwork of regulations that generally align with international standards, particularly those issued by the International Telecommunication Union (ITU) and regional policy forums. While specific requirements vary country by country, most national regulators allow UWB devices to operate—often unlicensed—in the 3.1–10.6 GHz band, subject to strict power spectral density limits. These constraints ensure that UWB transmissions remain low-power and short-range, minimizing the likelihood of interference with incumbent services such as mobile communications, satellite links, and defense or meteorological radars.

Beyond the major markets of China, Japan, and South Korea, the rest of the Asia Pacific region exhibits a diverse patchwork of UWB regulations that generally align with global best practices. Countries such as Afghanistan, Australia, Brunei, Cambodia, Fiji, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, and Vietnam have each introduced their own frameworks to ensure coexistence with incumbent services. These frameworks commonly stipulate stringent power spectral density (PSD) limits near −41.3-41.3−41.3 dBm/MHz in the 6–9 GHz range, although some nations also allow UWB operation below 6 GHz or above 9 GHz, subject to additional mitigation measures such as low duty cycle (LDC), dynamic frequency selection (DAA), or strict indoor-only usage.

Australia, for instance, regulates UWB transmitters under the Radiocommunications (Low Interference Potential Devices) Class Licence 2015, specifying different PSD levels and referencing ETSI EN 302 065 to address potential interference. India's approach, outlined in documents like GSR 1046(E), includes detailed sub-bands within the 1.6–10.6 GHz range and often mandates LDC or DAA for higher-risk segments (for example, 3.1–3.4 GHz, 3.4–3.8 GHz, or 8.5–9.0 GHz). Pakistan mirrors a similar strategy under its Regulatory Framework for Short Range Devices (SRD) & Terrestrial IoT Services, allowing −41.3-41.3−41.3 dBm/MHz in most UWB ranges but imposing lower limits in certain frequency blocks to protect satellite and radar operations.

Malaysia's Class Assignment (CA) framework covers UWB devices in bands stretching from 3.1–10.6 GHz, with specific PSD limits for road or rail vehicles, building-mounted equipment, and confined indoor scenarios. New Zealand's Radiocommunications Regulations (General User Radio Licence for Ultra-wide Band Devices) Notice 2017 also draws on −41.3-41.3−41.3 dBm/MHz as a baseline limit but includes unique provisions for devices installed in road and rail vehicles, requiring transmit power control with at least a 12 dB dynamic range or else defaulting to a lower PSD (−53.3-53.3−53.3 dBm/MHz). Meanwhile, Afghanistan has a simpler approach, licensing UWB for indoor use in the 6.4–10.7 GHz band at −41.3-41.3−41.3 dBm/MHz since 2010, aiming to limit interference with other services.

Other nations in the region have similarly rules. Singapore's IMDA TS UWB sets different thresholds for bands like 3.4–4.2 GHz, 4.2–4.8 GHz, and 6.0–9.0 GHz, mandating mitigation technologies for certain channels. Thailand's NBTC notification divides the 1.6–10.6 GHz range into multiple PSD tiers ranging from −62-62−62 dBm/MHz to −41.3-41.3−41.3 dBm/MHz, while Vietnam's MIC Circular No. 08/2021/TT-BTTTT primarily permits unlicensed use at −41.3-41.3−41.3 dBm/MHz in indoor settings or with shielding. Across these varied national policies, the common thread is the need to safeguard incumbent systems—particularly radar, satellite, and licensed mobile networks—while still offering pathways for UWB-based innovation.

6.16. UWB social and economic value in Morocco

Morocco's UWB market reflects a nascent but steadily growing integration of UWB solutions. For instance, "rider identification in private transport services" is projected to grow from 0.55 million units in 2024 to 3.36 million by 2030, highlighting a notable emphasis on secure and precise mobility. Smart home–related use cases, such as "point and trigger controller app," also show early adoption patterns that are expected to expand as local infrastructure and consumer awareness mature. As detailed below, these trends suggest that while overall UWB penetration remains comparatively modest, Morocco is laying the groundwork for more extensive UWB-driven innovations over time (see Table 6-31).

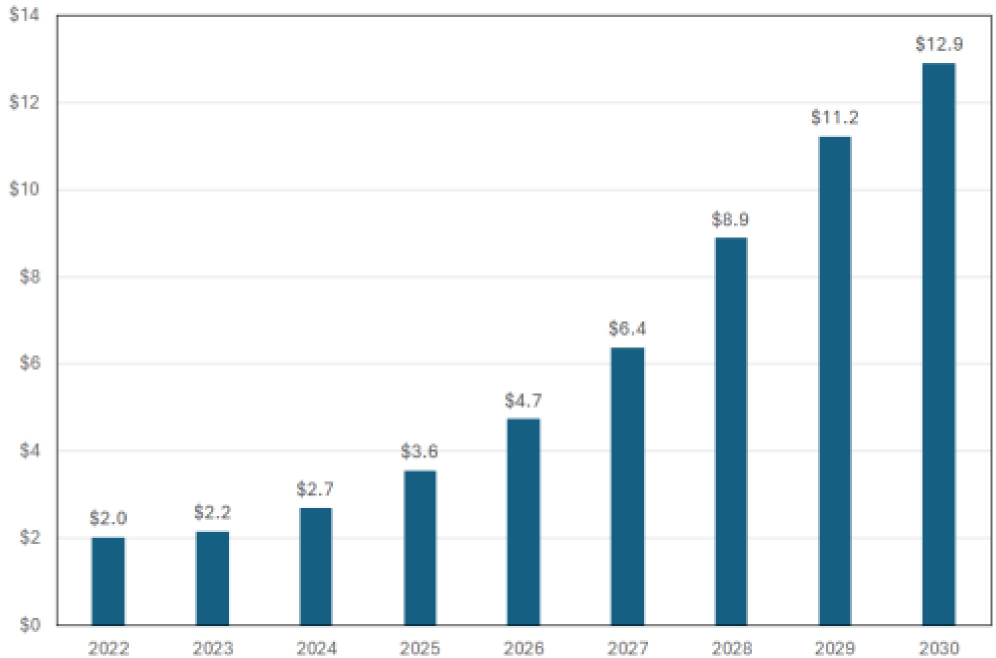
Table 6-31. Morocco: Units by use case

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	0.65	0.20%	3.79	0.37%
	Residential access control	0.01	0.20%	0.19	0.37%
	Easy (logistical) access to personal devices	0.00	0.20%	0.02	0.37%
	All gaming	0.01	0.20%	0.19	0.37%
	Audio streaming	0.00	0.20%	0.03	0.37%
	Gesture-based control	0.01	0.20%	0.19	0.37%
	VR gaming and group play	0.01	0.20%	0.19	0.37%
	Find someone/something nearby	0.06	0.20%	0.46	0.37%
	Smart speaker	0.03	0.20%	0.17	0.37%
	Presence-based device activation	0.00	0.20%	0.05	0.37%
Mobility	Parking garage access control	0.02	0.06%	0.03	0.02%
	Indoor navigation	0.02	0.06%	0.03	0.02%
	Vehicle digital key (car access)	0.00	0.06%	0.01	0.02%
	Rider identification in private transport services	0.55	0.20%	3.36	0.37%
	eID validation in crowded environments	0.55	0.20%	3.36	0.37%
	V2X and autonomous driving	0.02	0.06%	0.03	0.02%
	Driverless valet parking	0.02	0.06%	0.03	0.02%
	EV charging	0.00	0.06%	0.01	0.02%
	Toll collection	0.02	0.06%	0.03	0.02%
	Open trunk with gesture	0.00	0.06%	0.00	0.02%
	In cabin sensing	0.00	0.06%	0.01	0.02%
Individual consumer	Smart watches	0.09	0.20%	0.43	0.37%
	UWB smartphones	0.55	0.20%	3.36	0.37%
Smart retail	Tap-free mobile payment	0.55	0.20%	3.36	0.37%
	Unmanned store access	0.00	0.01%	0.00	0.01%
	Foot traffic and shopping behavior analytics	0.00	0.01%	0.00	0.01%
	Exhibition attendee management	0.00	0.01%	0.00	0.01%
	Targeted marketing	0.00	0.01%	0.00	0.01%
	Drone controlled delivery	0.00	0.01%	0.01	0.01%
	In-vehicle payment	0.02	0.06%	0.03	0.02%
Industrial	Indoor navigation	0.00	0.01%	0.00	0.01%
	Proximity-based patient data sharing	0.00	0.01%	0.00	0.01%
	Teleconference system	0.00	0.01%	0.00	0.01%
	Patient tracking	0.00	0.01%	0.00	0.01%
	Industrial real-time location systems	0.00	0.01%	0.00	0.01%
Public transportation	Ticket validation	0.55	0.20%	3.36	0.37%
	Reserved seat validation	0.55	0.20%	3.36	0.37%
	Ride sharing (precise positioning)	0.55	0.20%	3.36	0.37%
	Transportation sharing (find a bike or scooter nearby)	0.55	0.20%	3.36	0.37%
	Transportation fare payment	0.55	0.20%	3.36	0.37%
Smart building	Physical Access control	0.55	0.20%	3.36	0.37%
	Controlled access	0.55	0.20%	3.36	0.37%
	Employee gathering in emergencies	0.55	0.20%	3.36	0.37%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

Morocco's UWB contribution to GDP is projected to reach about USD 2.7 million by 2024, reflecting a nascent but growing application of UWB technologies. By 2030, this figure is expected to climb to USD 12.9 million, underscoring a gradual yet meaningful expansion of UWB deployment as local industries and infrastructures mature. Cumulatively, from 2022 through 2030, these annual gains are estimated to exceed USD 54 million, highlighting the steady impact that incremental UWB integration can have on Morocco's broader economic development (see Graphic 6-46).

Graphic 6-46. Morocco: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

Morocco's emerging UWB ecosystem is expected to generate a steady rise in employment opportunities, reflecting the growing demand for technical and service-oriented roles as UWB use cases gain traction. By 2024, these new positions are anticipated to reach 93 job years, expanding to 565 by 2030 as adoption accelerates across various sectors. Cumulatively, from 2022 to 2030, these job additions are forecast to total 2,008 job years, highlighting the progressive impact of UWB implementation on Morocco's labor market (see Table 6-32).

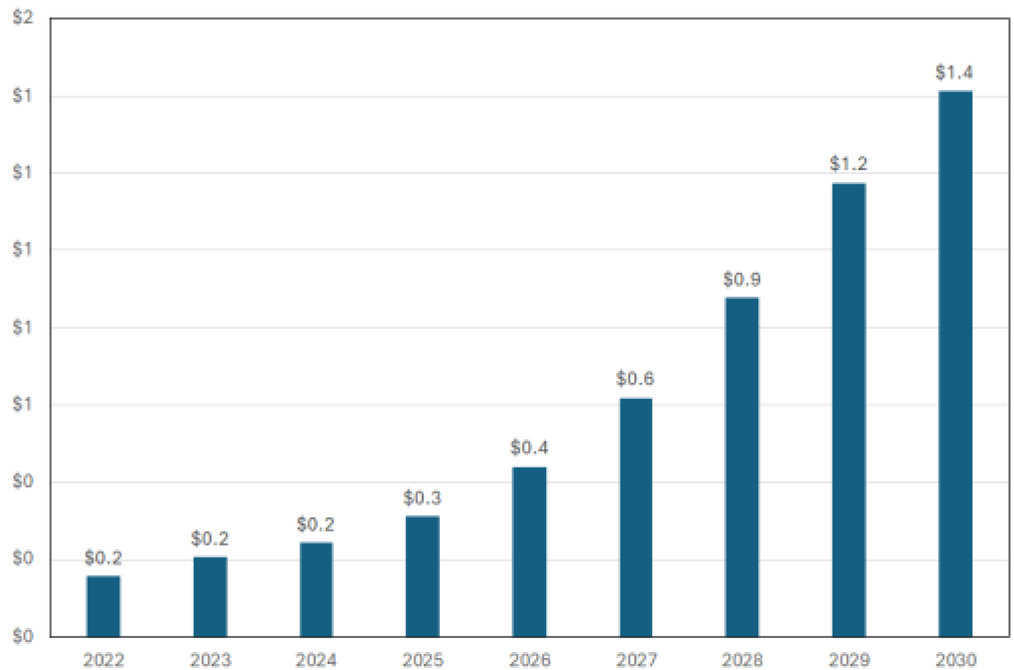
Table 6-32. Morocco: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
70	75	93	123	164	222	308	388	565	2,008

Source: Telecom Advisory Services analysis based on input/output matrix

Morocco's producer surplus from UWB is expected to reach around USD 0.2 million by 2024, reflecting the early-stage advantages gained as enterprises adopt UWB. By 2030, this figure is projected to climb to USD 1.4 million, highlighting a gradual yet steady increase in operational efficiencies driven by UWB deployment. Cumulatively, between 2022 and 2030, these incremental improvements are estimated to surpass USD 5 million, emphasizing the potential for continuous, long-term productivity gains as Morocco's UWB adoption accelerates (see Graphic 6-47).

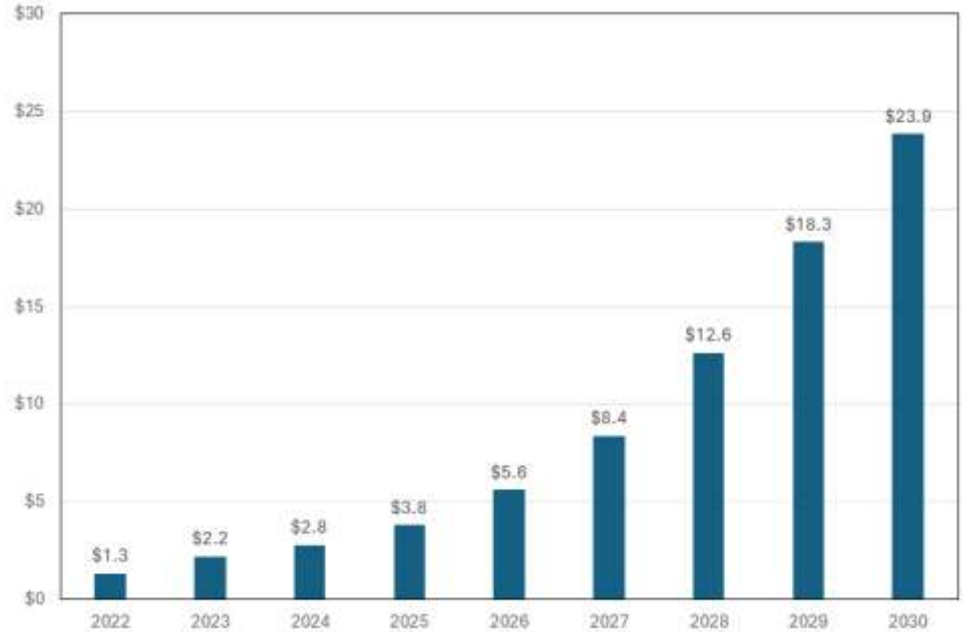
Graphic 6-47. Morocco: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Morocco's consumer surplus from UWB is forecast to reach around USD 2.8 million by 2024, reflecting early but tangible benefits for users. By 2030, this figure is anticipated to climb to USD 23.9 million, highlighting broader adoption and deeper integration of UWB-enabled applications. Cumulatively, from 2022 through 2030, these annual gains are estimated to surpass USD 78 million, illustrating how incremental progress in UWB deployment can deliver substantial long-term value to Moroccan consumers (see Graphic 6-48).

Graphic 6-48. Morocco: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In Morocco, the National Telecommunications Regulatory Agency (ANRT) is tasked with overseeing UWB operations to ensure that device emissions do not interfere with incumbent services. While Morocco does not maintain a dedicated, UWB-specific rule set on par with certain international frameworks, it generally adopts the emission constraints and technical guidelines championed by the International Telecommunication Union (ITU). In practice, this means that UWB devices typically operate within the 3.1–10.6 GHz frequency range under strict power spectral density limits, thus minimizing the possibility of harmful interference with licensed mobile networks, satellite links, and radar services.

Manufacturers wishing to commercialize UWB equipment in Morocco must undergo a type-approval or certification process, demonstrating that their devices conform to established emission thresholds[77]. Although UWB typically qualifies as an unlicensed, low-power technology, the ANRT reserves the right to institute additional constraints—such as limiting usage environments or imposing lower emission ceilings—if deemed necessary for protecting vital national communications and spectrum incumbents. As new UWB applications emerge—ranging from precision tracking in logistics to contactless payment systems—Moroccan regulators periodically review existing frameworks to accommodate technological advances without undermining spectrum integrity.

6.17. UWB social and economic value in Saudi Arabia

Saudi Arabia's UWB landscape exhibits a modest yet growing adoption across consumer and enterprise sectors alike. For instance, "rider identification in private transport services"

[77] https://www.anrt.ma/en/e-services/agrements-des-equipements

demonstrates a climb from 0.87 million units in 2024 to 3.13 million by 2030, indicating early interest in secure, real-time mobility applications. Moreover, areas such as "tap-free mobile payment" and "physical access control" also highlight the kingdom's move toward frictionless consumer experiences and enhanced operational efficiencies. As detailed below, these metrics reveal how Saudi Arabia, while still in the early stages of UWB deployment, is steadily fostering a market for wireless precision and secure connectivity solutions (see Table 6-33).

Table 6-33. Saudi Arabia: Units by use case

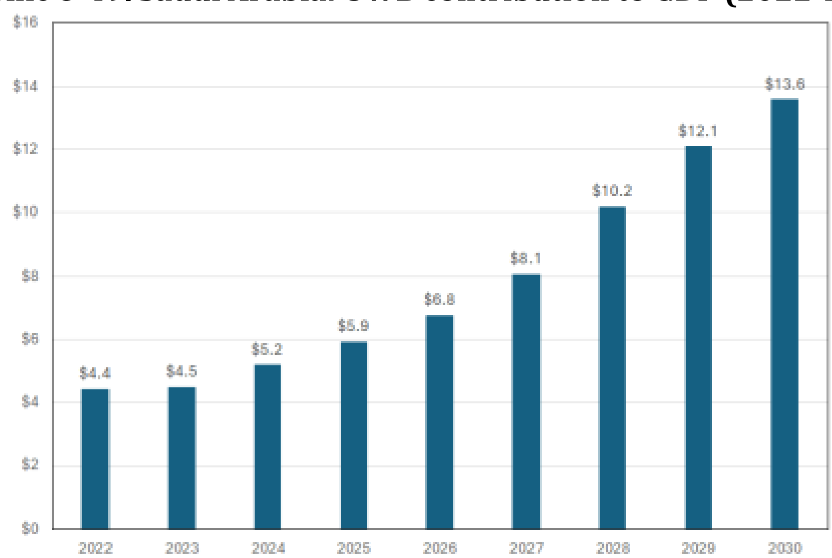
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	1.01	0.31%	3.53	0.35%
	Residential access control	0.02	0.31%	0.18	0.35%
	Easy (logistical) access to personal devices	0.00	0.31%	0.02	0.35%
	All gaming	0.02	0.31%	0.18	0.35%
	Audio streaming	0.00	0.31%	0.03	0.35%
	Gesture-based control	0.02	0.31%	0.18	0.35%
	VR gaming and group play	0.02	0.31%	0.18	0.35%
	Find someone/something nearby	0.10	0.31%	0.43	0.35%
	Smart speaker	0.05	0.31%	0.16	0.35%
	Presence-based device activation	0.00	0.31%	0.05	0.35%
Mobility	Parking garage access control	0.05	0.22%	0.10	0.07%
	Indoor navigation	0.05	0.22%	0.10	0.07%
	Vehicle digital key (car access)	0.01	0.22%	0.02	0.07%
	Rider identification in private transport services	0.87	0.31%	3.13	0.35%
	eID validation in crowded environments	0.87	0.31%	3.13	0.35%
	V2X and autonomous driving	0.05	0.22%	0.10	0.07%
	Driverless valet parking	0.05	0.22%	0.10	0.07%
	EV charging	0.02	0.22%	0.03	0.07%
	Toll collection	0.05	0.22%	0.10	0.07%
	Open trunk with gesture	0.00	0.22%	0.00	0.07%
	In cabin sensing	0.00	0.22%	0.02	0.07%
Individual consumer	Smart watches	0.14	0.31%	0.40	0.35%
	UWB smartphones	0.87	0.31%	3.13	0.35%
Smart retail	Tap-free mobile payment	0.87	0.31%	3.13	0.35%
	Unmanned store access	0.01	0.10%	0.02	0.06%
	Foot traffic and shopping behavior analytics	0.01	0.10%	0.02	0.06%
	Exhibition attendee management	0.01	0.10%	0.02	0.06%
	Targeted marketing	0.01	0.10%	0.02	0.06%
	Drone controlled delivery	0.03	0.10%	0.07	0.06%
	In-vehicle payment	0.05	0.22%	0.10	0.07%
Industrial	Indoor navigation	0.01	0.10%	0.02	0.06%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Proximity-based patient data sharing	0.01	0.10%	0.02	0.06%
	Teleconference system	0.00	0.10%	0.01	0.06%
	Patient tracking	0.01	0.10%	0.02	0.06%
	Industrial real-time location systems	0.01	0.10%	0.02	0.06%
Public transportation	Ticket validation	0.87	0.31%	3.13	0.35%
	Reserved seat validation	0.87	0.31%	3.13	0.35%
	Ride sharing (precise positioning)	0.87	0.31%	3.13	0.35%
	Transportation sharing (find a bike or scooter nearby)	0.87	0.31%	3.13	0.35%
	Transportation fare payment	0.87	0.31%	3.13	0.35%
Smart building	Physical Access control	0.87	0.31%	3.13	0.35%
	Controlled access	0.87	0.31%	3.13	0.35%
	Employee gathering in emergencies	0.87	0.31%	3.13	0.35%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

Saudi Arabia's UWB contribution to GDP is projected to reach approximately USD 5.2 million by 2024. By 2030, this figure is expected to climb to USD 13.6 million, underscoring a gradual but steady increase in UWB adoption as both enterprises and consumers embrace wireless precision and real-time data. Cumulatively, from 2022 through 2030, these annual increments are estimated to exceed USD 70 million, highlighting the growing economic significance UWB could hold for Saudi Arabia over the long term (see Graphic 6-49).

Graphic 6-49. Saudi Arabia: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

Saudi Arabia's UWB rollout is poised to yield a modest but consistent increase in employment opportunities across technology and service domains. By 2024, UWB-related activities are expected to create 58 job years, eventually reaching 188 by 2030 as adoption intensifies in areas such as mobility, payment systems, and secure building access. Cumulatively, between 2022 and 2030, these positions are anticipated to total 828 job years, underscoring how the gradual integration of UWB solutions can positively influence the country's labor market over time (see Table 6-34).

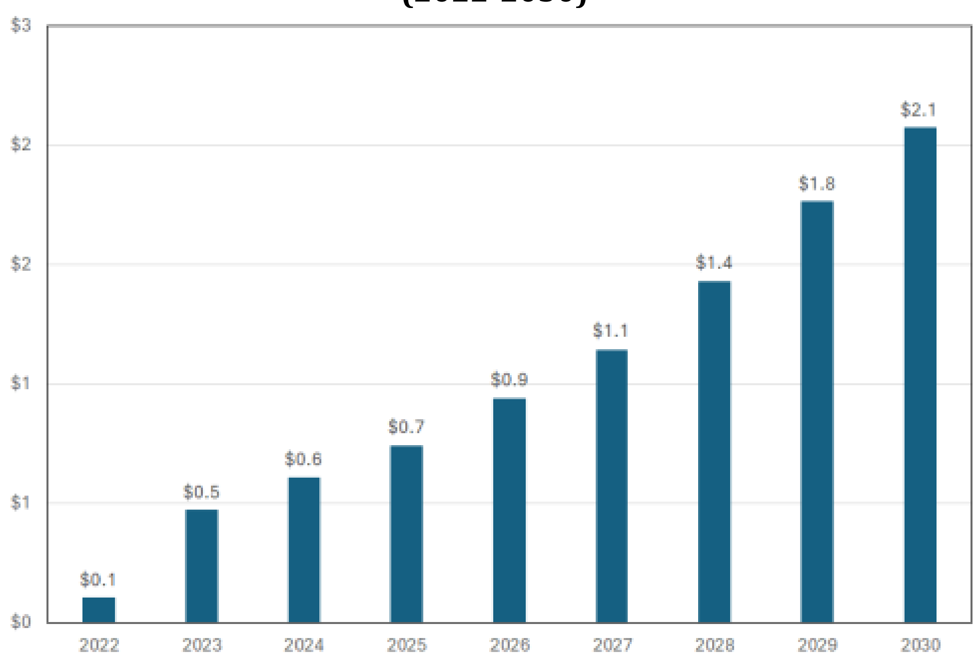
Table 6-34. Saudi Arabia: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
49	51	58	66	76	91	114	135	188	828

Source: Telecom Advisory Services analysis based on input/output matrix

Saudi Arabia's producer surplus from UWB is expected to reach approximately USD 0.6 million by 2024, indicating the initial operational gains as businesses integrate UWB technology. By 2030, the figure is anticipated to climb to USD 2.1 million, reflecting more widespread use of UWB-driven solutions across multiple sectors. Cumulatively, over the 2022–2030 period, these incremental improvements are estimated to nearly reach USD 9 million, underscoring the gradual but tangible impact UWB can have on enhancing productivity and reducing costs within the Kingdom's evolving digital landscape (see Graphic 6-50).

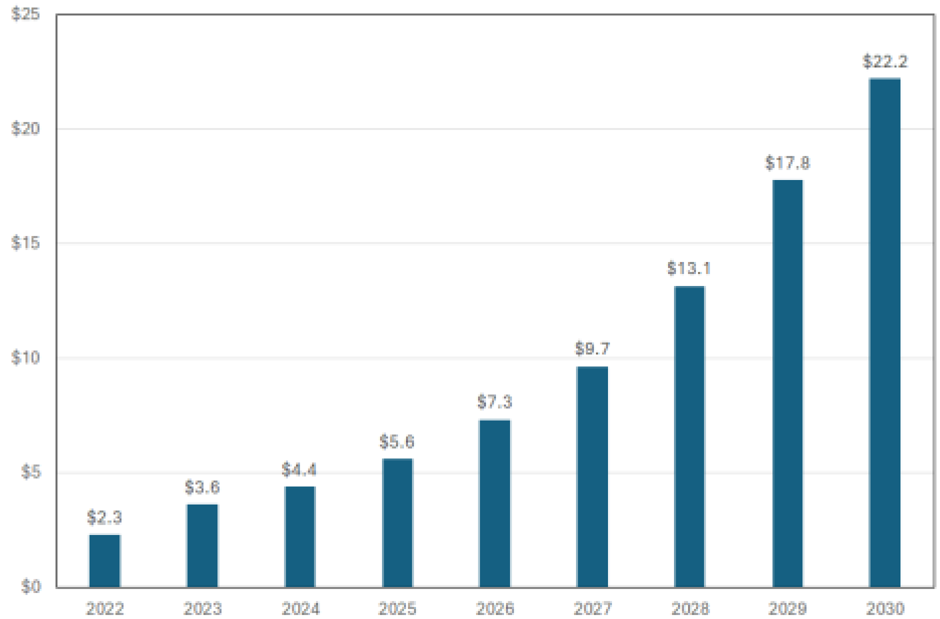
Graphic 6-50. Saudi Arabia: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Saudi Arabia's consumer surplus from UWB is expected to reach approximately USD 4.4 million by 2024, reflecting the nascent but growing adoption of UWB-enabled applications for everyday conveniences such as contactless payments and secure building access. By 2030, this figure is projected to climb to USD 22.2 million, underscoring a steady expansion in UWB-driven services that enhance consumer experiences. Cumulatively, between 2022 and 2030, these incremental annual gains are estimated to exceed USD 86 million, highlighting the long-term potential for UWB to significantly benefit end-users across the Kingdom (see Graphic 6-51).

Graphic 6-51. Saudi Arabia: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

In Saudi Arabia, the Communications, Space & Technology Commission (CST, formerly CITC) maintains primary oversight of UWB spectrum usage, ensuring that UWB devices operate without causing interference to critical incumbent services. As in many jurisdictions, UWB equipment typically functions in the 3.1–10.6 GHz band under strict power spectral density limits, aiming to prevent disruption to licensed mobile networks, satellite systems, and radar operations vital to national security and public services[78].

Manufacturers seeking to deploy UWB devices in Saudi Arabia must generally comply with type-approval or certification processes to confirm adherence to local emission masks and technical standards. While UWB is regarded as a short-range, low-power technology, the CST retains the authority to apply additional constraints—such as confining UWB deployments to indoor environments or mandating lower power levels—whenever there is a risk of interference with high-priority or safety-critical spectrum users[79].

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78 https://www.cst.gov.sa/ar/RulesandSystems/RegulatoryDocuments/EquipmentApproval/Documents/TA%20969%20E%20RI085.pdf

79 https://www.cst.gov.sa/en/RulesandSystems/RegulatoryDocuments/EquipmentApproval/Pages/default.aspx

6.18. UWB social and economic value in the rest of Middle East and North Africa

The rest of the Middle East and North Africa region demonstrates a moderate yet expanding interest in UWB adoption, encompassing both consumer-focused applications and public services. For instance, "tap-free mobile payment" and "rider identification in private transport services" are each projected to climb from approximately 5.10 million units in 2024 to 25.11 million by 2030, signaling a growing demand for precise, convenient, and secure transactions. Meanwhile, "point and trigger controller app" use is anticipated to increase from 5.96 million to 28.32 million, highlighting the region's appetite for streamlined home automation. These figures collectively suggest that UWB is steadily permeating various facets of daily life and commerce, laying the groundwork for wider-scale adoption in the years ahead (see Table 6-35).

Table 6-35. Rest of Middle East and North Africa: Units by use case

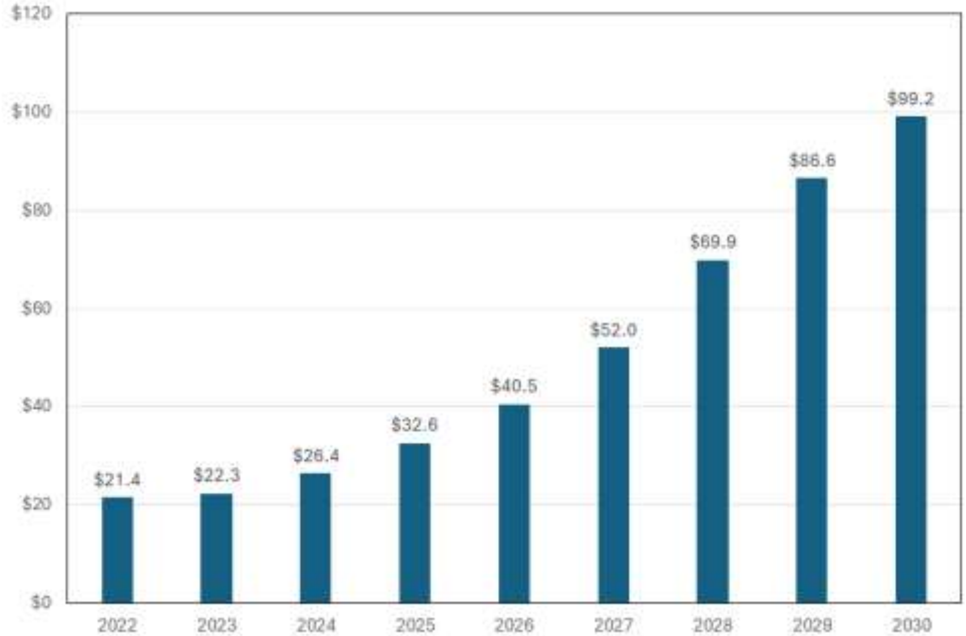
Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
Smart home	Point and trigger controller app	5.96	1.84%	28.32	2.78%
	Residential access control	0.14	1.84%	1.45	2.78%
	Easy (logistical) access to personal devices	0.01	1.84%	0.17	2.78%
	All gaming	0.13	1.84%	1.41	2.78%
	Audio streaming	0.00	1.84%	0.23	2.78%
	Gesture-based control	0.14	1.84%	1.45	2.78%
	VR gaming and group play	0.13	1.84%	1.41	2.78%
	Find someone/something nearby	0.58	1.84%	3.41	2.78%
	Smart speaker	0.29	1.84%	1.29	2.78%
	Presence-based device activation	0.00	1.84%	0.39	2.78%
Mobility	Parking garage access control	0.14	0.57%	0.27	0.19%
	Indoor navigation	0.14	0.57%	0.27	0.19%
	Vehicle digital key (car access)	0.03	0.57%	0.06	0.19%
	Rider identification in private transport services	5.10	1.84%	25.11	2.78%
	eID validation in crowded environments	5.10	1.84%	25.11	2.78%
	V2X and autonomous driving	0.14	0.57%	0.27	0.19%
	Driverless valet parking	0.14	0.57%	0.27	0.19%
	EV charging	0.04	0.57%	0.08	0.19%
	Toll collection	0.14	0.57%	0.27	0.19%
	Open trunk with gesture	0.00	0.57%	0.01	0.19%
	In cabin sensing	0.01	0.57%	0.06	0.19%
Individual consumer	Smart watches	0.85	1.84%	3.22	2.78%
	UWB smartphones	5.10	1.84%	25.11	2.78%
Smart retail	Tap-free mobile payment	5.10	1.84%	25.11	2.78%
	Unmanned store access	0.02	0.29%	0.05	0.16%
	Foot traffic and shopping behavior analytics	0.02	0.29%	0.05	0.16%

Area	Use case	2024		2030	
		Units (in million)	Share of world installed base	Units (in million)	Share of world installed base
	Exhibition attendee management	0.02	0.29%	0.05	0.16%
	Targeted marketing	0.02	0.29%	0.05	0.16%
	Drone controlled delivery	0.09	0.29%	0.19	0.16%
	In-vehicle payment	0.14	0.57%	0.27	0.19%
Industrial	Indoor navigation	0.02	0.29%	0.05	0.16%
	Proximity-based patient data sharing	0.02	0.29%	0.04	0.16%
	Teleconference system	0.00	0.29%	0.02	0.16%
	Patient tracking	0.02	0.29%	0.04	0.16%
	Industrial real-time location systems	0.02	0.29%	0.05	0.16%
Public transportation	Ticket validation	5.10	1.84%	25.11	2.78%
	Reserved seat validation	5.10	1.84%	25.11	2.78%
	Ride sharing (precise positioning)	5.10	1.84%	25.11	2.78%
	Transportation sharing (find a bike or scooter nearby)	5.10	1.84%	25.11	2.78%
	Transportation fare payment	5.10	1.84%	25.11	2.78%
Smart building	Physical Access control	5.10	1.84%	25.11	2.78%
	Controlled access	5.10	1.84%	25.11	2.78%
	Employee gathering in emergencies	5.10	1.84%	25.11	2.78%

Sources: Techno Systems Research; ABI Insight; GSMA Intelligence; IMF; OICA; Telecom Advisory Services analysis

The rest of the Middle East and North Africa region's UWB contribution to GDP is projected to reach USD 26.4 million by 2024, reflecting early-stage expansion of UWB applications. By 2030, this figure is anticipated to climb to USD 99.2 million, demonstrating a significant broadening of UWB adoption across various economic sectors. Cumulatively, from 2022 through 2030, these annual increments are estimated to exceed USD 450 million, underscoring how sustained UWB deployment can meaningfully enhance the region's overall economic output over time (see Graphic 6-52).

Graphic 6-52. Rest of Middle East and North Africa: UWB contribution to GDP (2022-2030)



Sources: Techno Systems Research; Telecom Advisory Services analysis

The rest of the Middle East and North Africa region is anticipated to see a modest but steady rise in employment opportunities connected to UWB. By 2024, these new roles are expected to total 504 job years, growing further to 2,835 by 2030. Cumulatively, from 2022 through 2030, this expansion is projected to add up to 10,261 job years, reflecting how incremental, year-by-year gains can converge into a notable long-term impact on the region's labor market (see Table 6-36).

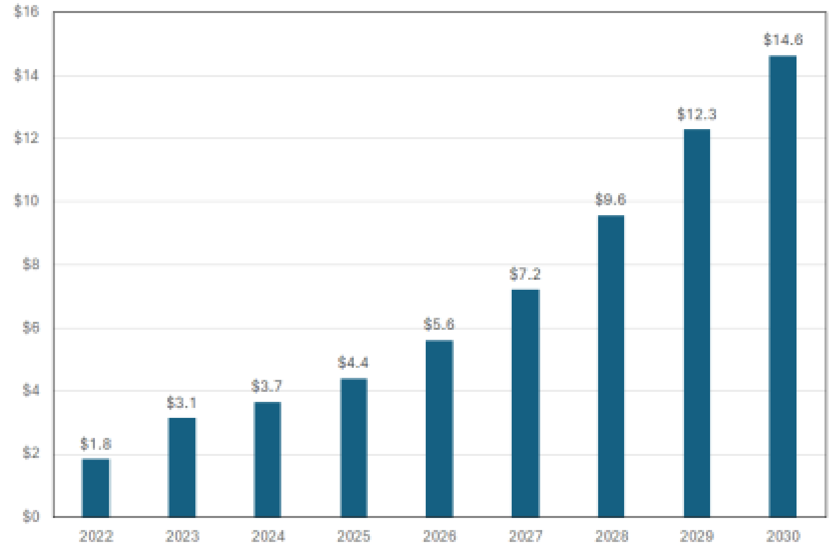
Table 6-36. Rest of Middle East and North Africa: Number of jobs created (2022-2030)

2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
394	421	504	649	846	1,127	1,546	1,940	2,835	10,261

Source: Telecom Advisory Services analysis based on input/output matrix

The rest of the Middle East and North Africa region's producer surplus from UWB is anticipated to reach approximately USD 3.7 million by 2024, reflecting early-stage efficiency improvements. By 2030, this figure is projected to climb to USD 14.6 million, underscoring a gradual but steady integration of UWB-driven processes across diverse economic segments. Cumulatively, between 2022 and 2030, these incremental gains are estimated to exceed USD 62 million, highlighting how consistent advances in UWB adoption can bring about meaningful long-term productivity benefits (see Graphic 6-53).

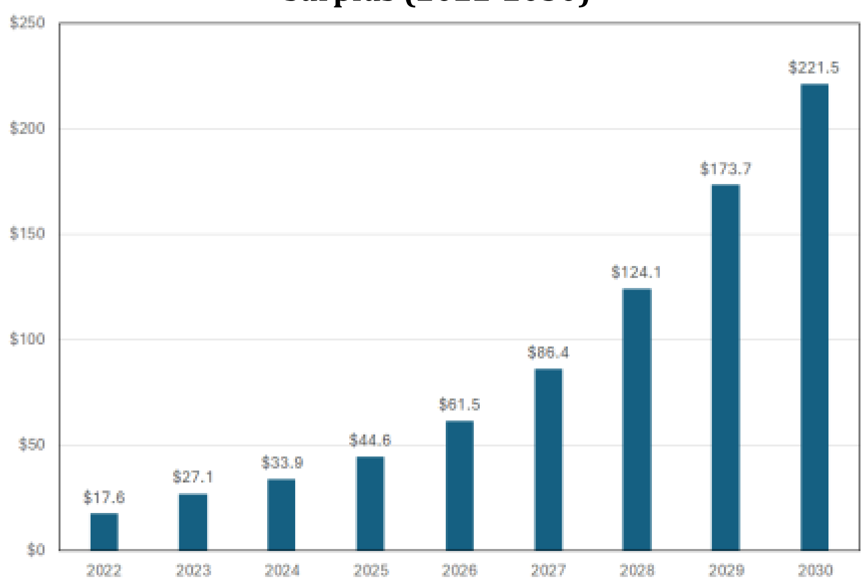
Graphic 6-53. Rest of Middle East and North Africa: UWB contribution to producer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

The rest of the Middle East and North Africa region's consumer surplus from UWB is projected to reach approximately USD 33.9 million by 2024, highlighting the early but noticeable advantages of UWB-enabled solutions in everyday tasks. By 2030, this figure is forecast to climb to USD 221.5 million, pointing to a sustained expansion of UWB use cases that enhance convenience and efficiency for consumers. Cumulatively, from 2022 through 2030, these annual increments are estimated to exceed USD 790 million, underscoring the long-term potential for UWB to significantly enrich the consumer experience across the broader region (see Graphic 6-54).

Graphic 6-54. Rest of Middle East and North Africa: UWB contribution to consumer surplus (2022-2030)



Sources: Telecom Advisory Services analysis

Across the remaining countries in the Middle East and North Africa region, UWB regulation follows a varied yet broadly international framework. Local telecommunications authorities typically refer to guidelines promulgated by the International Telecommunication Union (ITU) and, where relevant, the standards adopted by leading markets in Europe and North America. Consequently, UWB operations within the 3.1–10.6 GHz band are generally permitted under stringent power spectral density limits that protect incumbent services, which may include commercial mobile networks, satellite operations, and governmental or defense-specific radars.

In most of these jurisdictions, UWB is considered a low-power, short-range technology suitable for unlicensed use, provided that device manufacturers meet predefined emission masks and certification criteria. Through type-approval processes, regulators verify compliance with the emission thresholds necessary for safe coexistence among multiple spectrum users. In some cases, additional restrictions—such as confining UWB to indoor operations or further lowering power limits—may be imposed if new applications or local conditions present potential interference concerns.

7. CONCLUSIONS

The economic and social impact of UWB technology, as documented throughout this report, underscores its significance as a transformative wireless solution poised to accelerate innovation, productivity, and consumer welfare. While diverse sectors—ranging from consumer electronics to public transportation—demonstrate varied adoption trajectories, the overarching trend is one of steady growth in both economic output and societal benefits (See Table 7-1).

Table 7-1. Global Economic Impact (2022-2030) (US$ Millions)

Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR
Gross Domestic Product	$1,824.99	$1,929.58	$2,360.45	$3,024.95	$3,736.62	$4,436.93	$5,141.11	$5,875.68	$6,553.14	17.33%
Producer Surplus	$1,878.53	$2,769.90	$3,577.11	$4,746.56	$6,354.09	$8,183.12	$10,301.10	$12,681.72	$15,258.64	29.93%
Consumer Surplus	$3,114.64	$4,041.30	$4,554.33	$5,627.14	$7,245.21	$ 9,180.22	$11,126.52	$13,038.66	$14,944.24	21.66%
TOTAL	$6,818.17	$8,740.78	$10,491.89	$13,398.65	$17,335.92	$21,800.27	$26,568.73	$31,596.06	$36,756.02	23.44%

Source: Telecom Advisory Services analysis.

A key insight emerging from the study is that UWB's socio-economic value extends beyond traditional productivity gains. As shown in multiple sections, UWB acts as a catalyst for labor market development while simultaneously enhancing safety-related outcomes (while challenging to monetize directly in economic calculations, these safety-driven UWB deployments represent an important complement to the productivity metrics covered in this study). In fact, by enabling more secure child presence detection in vehicles or precise tracking of firefighters during emergencies, UWB contributes to avoided medical and legal costs—areas typically not captured in conventional surplus metrics. This dimension indicates that UWB's capacity to reduce societal risks (e.g., accidents, injuries) amounts to monetary savings in healthcare and judicial resources increasing the economic impact presented previously.

From a global standpoint, the cumulative Gross Domestic Product contribution of UWB showcases a notable upward trajectory. As detailed in prior chapters, sectors such as Mobility and Smart Retail are on track to record sizable revenue increments, reflecting how consumer demand for frictionless payment systems, location precision, and streamlined industrial processes feeds into macro-level growth. Equally important, the data reveals that, although still in the early adoption phase, emerging markets in Africa, Latin America, and parts of Asia Pacific are expected to see accelerated benefits once local infrastructure and regulatory frameworks align more closely with global UWB standards.

Producer surplus trends, driven by cost reductions and operational efficiencies, further validate UWB's impact. As businesses adopt automated inventory tracking, device-free localization, and advanced teleconferencing through UWB solutions, they capture gains in productivity. Over time, these incremental improvements expand into substantial cost avoidance, supply chain optimization, and reduced manual intervention—effects that cascade upstream to suppliers and downstream to end-users. This was exemplified by analyses across industrial and retail sectors, where the synergy of UWB technology with existing automation frameworks fosters new revenue pathways and operational efficiencies.

On the consumer front, UWB consistently proves to be a driver of convenience and time savings. Several use cases, including tap-free mobile payment, precise ride sharing, and occupant sensing in vehicles, highlight direct gains in daily routines, from shorter wait times to greater peace of mind. These improvements, measured as consumer surplus, grow in tandem with device penetration rates. Notably, adoption accelerates once users become acquainted with the tangible benefits—faster payment checkouts, secure access control, or the reassurance that a child or elderly occupant in a vehicle is monitored in real time.

In summary, between 2022 and 2030, the Gross Domestic Product attributable to UWB is projected to grow from US$1,824.99 million to US$6,553.14 million, underscoring an expanding market driven by more diverse use cases and broader geographic uptake. Over the same period, Producer Surplus is projected to increase from US$1,878.53 million to US$15,258.64 million, as businesses achieve greater operational efficiencies and develop new revenue streams. Consumer Surplus likewise is projected to rise markedly—from US$3,114.64 million to US$14,944.24 million—mirroring the enhanced convenience and time savings experienced by end-users across mobility, retail, and smart home scenarios. Taken together, these three areas push the total economic impact of UWB from US$6,818.17 million in 2022 to US$36,756.02 million by the end of the decade, showcasing the technology's rapid momentum in delivering both direct economic value and widespread societal benefits.

Another critical dimension is spectrum availability and channel capacity requirements. Although many UWB applications (such as Car Connectivity Consortium use cases) might efficiently operate with two channels, more advanced deployments by FiRa and Aliro may require up to three channels at full implementation to accommodate enhanced location precision, multi-device coordination, and robust data throughput. This underscores the need for continued regulatory flexibility that can adapt to the rising demand for UWB spectrum resources over time.

Furthermore, safety-oriented UWB deployments demonstrate a clear societal dimension that transcends basic economic metrics. Improved firefighter location tracking significantly lowers the risk of injury in hazardous environments, while precise detection of child presence in cars potentially averts life-threatening incidents. These advancements alleviate pressures on healthcare systems, reduce legal proceedings, and lessen emotional burdens for families, thus yielding considerable social value. Integrating these safety-driven savings into broader cost-benefit calculations may reveal an even higher aggregate value for UWB.

As a result, governments and regulatory bodies face the imperative to craft supportive policies that balance innovative growth with protection of incumbent spectrum services. Many regions follow international guidelines set by entities such as the International Telecommunication Union, enforcing emission masks near −41.3 dBm/MHz. While these constraints preserve spectral integrity, they must remain adaptive so that new applications—particularly those promoting social well-being—can flourish without causing interference.

Global usage patterns suggest that well-defined commercialization paths can unlock further innovations, especially as more advanced UWB chips enter the market. Growing demand for multi-channel capacity within higher frequency bands will likely accelerate expansions of unlicensed or lightly licensed segments. As seen in automotive V2X integration or sophisticated retail analytics, additional channels enable refined precision and multi-device tracking, thus broadening the technology's appeal.

While industrialized nations frequently lead in initial deployment, developing regions demonstrate a capacity for "leapfrog" adoption once foundational regulatory measures are in place. The synergy between local regulations, cost-competitive devices, and targeted pilot programs can accelerate UWB acceptance in emerging markets, leading to substantial socio-economic dividends—particularly in safety, healthcare, and secure payment domains. Continued collaboration with international standardization bodies fosters interoperability and economies of scale, essential for lowering prices and democratizing access.

Crucially, the synergy of UWB with complementary technologies—such as artificial intelligence, cloud analytics, and edge computing—augments its societal impact. Real-time data processing from UWB sensors underpins advanced safety applications, improved logistics, and smarter public transport systems. By coupling precise location capabilities with intelligent data management, organizations can shift from reactive operations to proactive optimization, thereby maximizing resource allocation and mitigating risks.

The analysis also illustrates that the benefits of UWB reach beyond monetary gains to encompass intangible improvements in user experience, confidence, and well-being. When considered alongside the direct economic surplus metrics, these intangible dimensions confirm UWB's broader contribution to quality of life. Policies and investments tailored to encouraging UWB integration in socially critical areas—firefighter equipment, child safety applications, or healthcare monitoring—yield returns that surpass basic revenue counts.

In summary, UWB technology stands at the intersection of economic efficiency, social responsibility, and regulatory innovation. Its adoption catalyzes new revenue streams, productivity enhancements, and labor market opportunities, while simultaneously reducing societal burdens through heightened safety and convenience. Going forward, aligned policies that promote flexible channel usage, adapt PSD limits as required by evolving use cases, and incentivize R&D into the social applications of UWB will help sustain the upward momentum charted in this report. By refining both technical standards and policy environments, stakeholders can ensure that UWB continues to serve as a linchpin for economic and social progress worldwide.

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