

TRANSPARENCY AS VALUE: PAST-MONTH CANNABIS CONSUMER & PATIENT RESPONSES TO QR CODE-ENABLED CANNABIS PRODUCT INFORMATION

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Summer **2026**



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Executive Summary

Cannabis consumers frequently make purchasing decisions under conditions of uncertainty, where important product characteristics such as laboratory testing, product authenticity, and regulatory compliance cannot be independently verified at the point of purchase. This study examined whether a standardized, state-issued QR code providing product-level regulatory information influences consumer perceptions and whether those perceptions translate into measurable economic value. Among more than 3,000 past-month cannabis consumers across legal U.S. jurisdictions, the findings suggest that digital transparency infrastructure may increase consumer confidence, strengthen perceptions of regulatory oversight, and generate measurable value beyond the cannabis product itself.

Key findings include:

- *Consumers reported greater confidence following exposure to the transparency system.* Respondents overwhelmingly reported that the QR code increased confidence in regulated cannabis products and improved understanding of product safeguards and regulatory oversight.
- *Standardization received broad support.* More than 95% of respondents supported making the same QR code-enabled information available across all regulated cannabis products, regardless of product type.
- *Consumers assigned measurable value to transparency.* Respondents reported a mean willingness to pay of \$3.48 (median = \$2.00) for products featuring the state-issued QR code-enabled transparency system.
- *Perceptions of trust appear to drive value.* Consumer perceptions of trust, safety, product quality, informational adequacy, and product legitimacy presented as an index was the most robust predictor of willingness to pay, suggesting that transparency generates value by increasing confidence in regulated products.
- *Transparency may be especially valuable where uncertainty is greatest.* Consumers reporting greater participation in illicit-market purchasing demonstrated higher willingness to pay for the transparency functionality, consistent with the hypothesis that transparency is most valuable where trusted product information is limited.
- *QR codes may serve two complementary functions.* Beyond increasing access to product information, state-issued QR codes may function as visible signals of regulatory oversight, product legitimacy, and consumer protection, strengthening confidence in the regulated cannabis marketplace.

Collectively, these findings suggest that state-issued QR code-enabled transparency systems may represent a practical strategy for strengthening consumer confidence, increasing the perceived value of regulated cannabis products, and reinforcing the role of regulatory oversight within legal cannabis markets. Regulators and industry stakeholders may be well served by considering the standardized implementation of state-issued QR code transparency systems across regulated cannabis products. Future research should evaluate whether implementation of standardized transparency systems translates into measurable changes in consumer purchasing behavior and participation in regulated markets.

A STUDY ON PAST-MONTH CANNABIS CONSUMER & PATIENT RESPONSES TO QR CODE-ENABLED CANNABIS PRODUCT INFORMATION

Study Design

Cross-sectional survey of past-month cannabis consumers & patients across **33 legal U.S. cannabis jurisdictions**



Descriptive Sample
N = 3,061



WTP Analytical Sample
N = 1,886

Study Overview

Examining consumer perceptions of, and willingness to pay for, state-issued QR code-enabled cannabis product information.

Consumer-Reported Valuable QR Code-Enabled Information



Laboratory testing results



Cannabinoid & terpenes profiles



Licensing & product information



Recall notifications



Public health resources

Consumer-Reported Value of State-Issued QR Codes



Verification of compliance



Product authentication



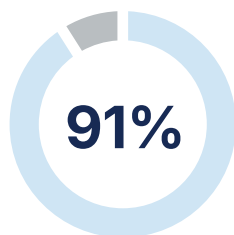
Consumer protection signals



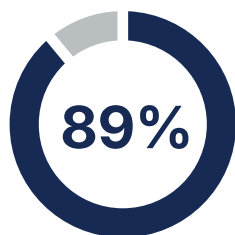
Increased confidence in regulated markets

Valued Information

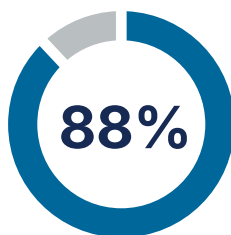
Respondents reported high perceived value for state-issued QR code-accessible information:



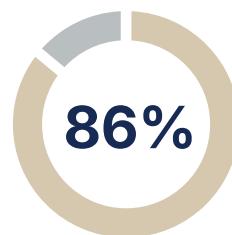
State Compliance Confirmation



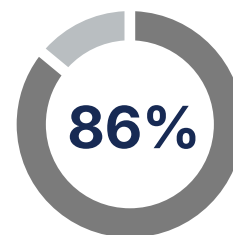
Lab Testing Verification



Recall Notifications



Product/Licensing Information



Cannabinoid and Terpene Profiles

Willingness to Pay

Consumers assigned measurable economic value to state-issued QR code-enabled product information.



Mean WTP: \$3.48

Median WTP: \$2.00

Willingness to pay (WTP) was significantly higher among registered medical cannabis patients, respondents residing in medical-only jurisdictions, and respondents who consumed cannabis at least weekly.

Willingness to Pay Predictors

Most Robust Predictor:

Regulatory Transparency Perception Index

- Trust
- Safety
- Quality
- Informational Adequacy
- Product Confidence

Market Spending Statistical Findings

Illicit market spending: positive association with WTP

Regulated market spending: no association with WTP

Consumer Perception

Agreement with statements following state-issued QR code exposure:



100%

Felt more protected by state regulator



91%

Helped understand consumer safeguards



90%

More likely to purchase from licensed dispensary



89%

Increased confidence in legal cannabis market



88%

Helped differentiate regulated from unregulated products

Recommendations

Regulators and industry stakeholders should consider standardized state-issued QR code-enabled cannabis product information across all regulated products, supported by consumer education on QR code access, product verification, testing, recalls, licensing, compliance, and public health resources. Future research should assess effects on trust, purchasing behavior, and regulated market participation.

Introduction

The expansion of legal cannabis markets across the United States has introduced new regulatory challenges related to consumer protection, market differentiation, and public trust. Although regulated cannabis systems are intended to provide safeguards through laboratory testing, licensing oversight, product tracking, and packaging standards, cannabis consumers and patients often operate within a total marketplace where regulated and unregulated purchases coexist.^{1,2,3,4,5} As a result, purchasing decisions may occur under conditions of informational uncertainty, particularly regarding product safety, composition, contamination risk, and regulatory compliance. Further, the existence of regulatory safeguards does not necessarily eliminate informational uncertainty if consumers cannot easily evaluate, authenticate, or interpret the signals intended to communicate product quality and compliance.

This challenge reflects a broader economic problem commonly described as information asymmetry, in which one party in a transaction possesses substantially greater information than the other.⁶ In regulated cannabis markets, consumers are often unable to independently verify underlying product characteristics, laboratory testing outcomes, or supply chain integrity beyond the limited information communicated through standard packaging and labeling requirements. Conversely, cultivators and manufacturers who have produced the product and are responsible for the practices that influence quality and compliance have immense knowledge about the product characteristics. Although regulated systems are designed to reduce uncertainty through labeling and standardized disclosures, these mechanisms may be constrained by label space, formatting, and readability limitations that reduce consumers' ability to meaningfully engage with or interpret the information provided at the point of purchase. These informational gaps may be especially pronounced among consumers sourcing products through illicit or informal channels, where standardized product verification mechanisms are absent.

From a behavioral economics perspective, uncertainty surrounding product quality and safety may meaningfully shape consumer decision-making.^{7,8} Cannabis products possess characteristics of what economists describe as “credence goods” or “experiential goods,” meaning that important dimensions of product quality cannot be fully evaluated by consumers until after purchase or consumption.⁹ Unlike conventional consumer goods where quality may be directly observable, cannabis consumers frequently rely on heuristics and institutional trust to infer whether products are accurately labeled, compliant with testing standards, and produced within regulated supply chains, despite often having access to only limited cannabinoid information, condensed laboratory summaries, and binary indicators of compliance communicated through current packaging and labeling systems.

Within markets characterized by incomplete information, signaling and transparency mechanisms may serve an important role in reducing uncertainty and shaping consumer perceptions. Current literature in information systems and institutional transparency suggests that transparency infrastructure may enhance perceptions of legitimacy and accountability while signaling stronger regulatory oversight, thereby creating conditions that may foster consumer trust in regulated markets.¹⁰ Under such conditions, the availability of information itself may acquire economic value when consumers perceive that it reduces uncertainty surrounding product composition, testing practices, or regulatory compliance.

This may be particularly relevant in cannabis markets, where regulatory requirements limit the amount of information that can be communicated on product labels, and illicit or counterfeit products may be difficult for consumers to distinguish from regulated products.

In response to these challenges, cannabis regulators and industry stakeholders have increasingly explored consumer-facing transparency systems intended to improve accessibility to granular product-level information. One emerging strategy proposed by Metrc, a traceability technology vendor that tracks products through state cannabis supply chains, involves the use of state-issued QR codes (i.e., quick response codes).¹¹ These QR codes link to state-managed interactive digital landing pages containing laboratory testing results, cannabinoid and terpene profiles, licensing verification, recall notices, public health resources, and more. These systems effectively transform condensed, static product labeling into digitally accessible transparency infrastructure capable of providing consumers with greater visibility into product provenance and regulatory oversight. By expanding access to product and regulatory information, these systems may function not only as informational tools, but also as signals of regulatory oversight, product legitimacy, and market credibility within environments where regulated and illicit products frequently compete simultaneously.

The potential value of state-managed QR code-enabled transparency may operate through at least two related mechanisms: first, by reducing uncertainty through expanded access to product information; and second, by functioning as a visible signal of regulatory oversight, legitimacy, and institutional trustworthiness independent of whether consumers fully engage with the underlying information. Together, both mechanisms may contribute to increased perceptions of product credibility, consumer confidence, and the relative value of participating in regulated cannabis markets.

Metrc commissioned Cannabis Public Policy Consulting LLC for the present study seeking to examine consumer perceptions and economic valuation of state-issued QR code-enabled cannabis product transparency systems among a large sample of past-month cannabis consumers residing in legal cannabis jurisdictions across the United States. Specifically, the study examined consumer perceptions of a state-issued QR code cannabis information system, including perceived trust, product quality, safety, informational adequacy, and consumer confidence, as well as measuring whether those perceptions were associated with hypothetical value attribution, measured by a positive willingness to pay (WTP), for enhanced transparency features. Additionally, the study examined whether cannabis sourcing behaviors, including participation in illicit market channels, were associated with differential valuation of QR-enabled transparency infrastructure.

By applying theoretical frameworks of information asymmetry and signaling theory, this study aims to contribute to a growing body of research examining how digitally mediated transparency systems may shape consumer decision-making within emerging regulated cannabis markets.

Information Asymmetry and Consumer Uncertainty in Cannabis Markets

Cannabis markets possess several structural characteristics that may contribute to elevated informational uncertainty during consumer decision-making. Unlike many conventional consumer products, cannabis products often contain quality attributes that are not directly observable at the point of purchase and are highly complex. Consumers may be unable to independently verify cannabinoid profiles, contaminant status, pesticide exposure, microbial safety, manufacturing conditions, or regulatory compliance without relying on external verification systems. As a result, purchasing decisions may occur under conditions where substantial informational asymmetries exist between consumers and market actors possessing greater product-level knowledge, including manufacturers, laboratories, retailers, and regulators.

Economic theories of information asymmetry suggest that markets characterized by incomplete or unevenly distributed information may experience reductions in consumer trust, increased uncertainty, and diminished confidence in product quality.¹² Within such environments, consumers frequently rely on observable signals to infer unobservable product characteristics.¹³ These signals may include branding, packaging, regulatory markings (e.g., universal symbol), institutional oversight cues (e.g., state seal, agency seal), or retailer reputation. As a result, transparency infrastructure, such as QR codes, may function not only as a tool for increasing access to product information, but also as a mechanism to increase certainty surrounding product legitimacy.

QR Code-Enabled Transparency as Signaling Infrastructure

Within regulated cannabis systems, QR code-enabled product information systems represent one emerging form of digitally mediated transparency infrastructure.

The present study examined consumer responses to a QR code that routes to a standardized, state-branded landing page with product-specific information including:

- confirmation of regulatory compliance,
- laboratory testing verification,
- cannabinoid and terpene profiles,
- manufacturer and dispensary licensing information,
- recall notifications, and
- public health resource links.

By linking physical product packaging to dynamic digital information environments, QR code systems may increase consumer access to product-level regulatory and safety-relevant information at the point of purchase or consumption.

Importantly, these systems may serve functions extending beyond informational accessibility alone. Signaling theory suggests that visible transparency mechanisms may communicate broader institutional signals related to oversight quality, accountability, legitimacy, and consumer protection.¹⁴ As such, the perceived value of standardized QR code-enabled transparency systems may emerge not only from the informational utility of the data provided, but also from what the existence of such systems communicates about product legitimacy, regulatory participation, and institutional trustworthiness.

Methodology

Pilot Phase

The current study followed an earlier pilot phase (2024-2025) utilizing a randomized experimental design involving mock cannabis packaging and labeling conditions, including a control condition. Respondents were randomized to one of six conditions of various mock product labeling cues and were asked a series of questions measuring trust, safety, quality and value. All respondents then reported on purchasing habits, product information use, labeling comprehension, awareness of product recalls and adverse health event reporting, and perceptions of safety and legitimacy within the regulated market. The labeling mock-ups varied in informational content and branding format, allowing CPCC to evaluate how differences in content, presentation, and framing shaped consumer interpretation and trust. Findings from the pilot phase were then used to inform the development of Metrc's final QR code landing page stimuli used in the present study, as well as the present observational study design.

Study Design and Recruitment

Cross-sectional data were collected between January and March 2026 through a 15-minute online survey hosted on Qualtrics™ and administered using Cint Global Marketplace Community Research Panels. Eligibility criteria included: (1) age 21 years or older in adult-use jurisdictions or age 18 years or older for registered medical cannabis patients in medical-only jurisdictions, and (2) self-reported past-month cannabis consumption. Respondents were recruited from 33 U.S. jurisdictions with operational, comprehensive medical and/or adult-use cannabis markets: Alaska, Arizona, California, Colorado, Connecticut, Delaware, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nevada, Montana, New Jersey, New Mexico, New York, Ohio, Oregon, Rhode Island, Vermont, Virginia, Washington, Mississippi, Kentucky, Oklahoma, Pennsylvania, Florida, Hawaii, South Dakota, Louisiana, West Virginia, Utah. This project was reviewed and approved under Exempt Status from an Institutional Review Board (IRB) in accordance with federal laws, and data security measures followed National Institute of Standards and Technology (NIST) standards.

The final cleaned survey sample consisted of 3,061 respondents. Analyses of willingness to pay were conducted on the subset of respondents ($n = 1,886$) who provided valid WTP values within the instructed response range. Respondents with invalid WTP entries were excluded only from WTP analyses; all other analyses used the full cleaned sample where responses to those measures were valid. Because willingness to pay was measured independently from the remaining survey constructs, responses considered invalid to this item do not imply invalidity of respondents' other answers and therefore do not warrant exclusion from unrelated analyses. This item-level exclusion approach preserves the integrity of the WTP analyses without unnecessarily discarding otherwise valid participant data that passed all attention checks, data cleaning and quality procedures.

Internal vs. External Validity

Given that the objective of this study was to test a series of hypotheses, the samples were not weighted. That is, our goal was to identify relationships (e.g., correlations, effects) rather than produce precise, population-representative prevalence statistics. Moreover, there is currently no dataset of which we would be able to derive weights for a representative sample of past-month cannabis consumers across all legal jurisdictions. In our single state or national research, we weight samples by deriving iterative proportional fitting weights from probability-based samples like the Behavioral Risk Factor Surveillance Study (BRFSS) and the National Study on Drug Use and Health (NSDUH). However, given that this is a multi-state study, much of the consuming population are medical consumers, and probability-based data for many of these states are under restricted access, there is no reasonable way to weigh this data to be wholly representative of past-month cannabis consumers across varying legal jurisdictions. As such, our methodology prioritizes internal validity, ensuring that the identified relationships are statistically robust and free from major confounding. However, given the large sample size in parity with U.S. Census demographics for national population (as most of the U.S. population resides in states with a form of legal cannabis access), and the consistency of observed relationships, the findings may possess a degree of external relevance despite the absence of population-based weighting procedures and probability-based sampling methods. Additional research through probability-based sampling is warranted for claims regarding external validity. Furthermore, experimental research is required for estimating any causal relationships.

Data Quality and Cleaning Procedures

Given the use of non-probability online panel recruitment, extensive data quality procedures were implemented to minimize invalid, automated, or low-engagement responses. Screening procedures included duplicate detection, IP verification, attention checks, re-CAPTCHA scoring, speed checks, responses in violation of one another, response patterning, and consistency verification across demographic and intake variables.

Select Descriptive Statistics - Attitudes, Perceptions and Beliefs

Survey respondents were presented with a demonstration of the proposed QR-system accompanied by a text description outlining its functionality. Specifically, participants viewed a mock-up of a state-issued QR code that, when scanned, directed users to a standardized state landing page featuring the regulatory agency branding, educational messaging, and product-specific information. The demonstration video scrolled through each of the landing page sections, highlighting each piece of information within the interactive platform. Throughout this paper, we refer to this collective system using the terms "state-issued QR code systems" or "state digital transparency systems", depending on the context.

Given the breadth of the survey instrument, only descriptive findings directly relevant to the study's theoretical framework and primary hypotheses are presented below. These descriptive measures were selected to contextualize the proposed relationships between state-issued QR code-enabled transparency, informational uncertainty, institutional trust, and willingness to pay. All values are rounded to the nearest whole number.

Perceived Value of State-Issued QR Code Landing Page Informational Elements

Our survey included observational questions inquiring about attitudes, perceptions and beliefs related to cannabis labels. Using the informational elements included in the example of the QR code-enabled landing page video demonstrated to the respondents, we asked respondents if they found the following informational elements valuable, as shown in Table 1.

Respondents overwhelmingly perceived each category of information accessible through the QR code system as valuable. The highest levels of perceived value were observed for confirmation from the state cannabis agency that the product was compliant with regulatory standards (91%) and detailed laboratory testing information, including passing test confirmation, official testing documentation, and laboratory licensing information (89%). Similarly, 88% of respondents reported that recall notifications would be valuable, while 86% valued detailed product and licensing information as well as expanded cannabinoid and terpene profiles inclusive of all cannabinoids and terpenes by weight and percentage. Although resource links to Poison Control and the state cannabis regulator received comparatively lower endorsement, a substantial majority of respondents still perceived these resources as valuable (79%).

Many of these informational elements substantially expand upon the level of detail typically communicated through conventional, physical cannabis labeling systems. Across most legal cannabis jurisdictions, physical product labels commonly include condensed disclosures such as THC/CBD potency, batch numbers, manufacturer information, warning statements, and limited indicators of testing compliance.

Table 1. Value of Informational Elements Presented in QR Code-Enabled Landing Page

	I find this information valuable	I do not find this information valuable	I am not sure
Confirmation from the state cannabis agency that the product is compliant	91%	6%	2%
The product information including: Serving size, package size, cannabis manufacturer name and license number, unique product identifier, and cannabis dispensary name and license number.	86%	11%	2%
The product cannabinoids profile including all cannabinoids and terpenes by weight and percentage	86%	9%	3%
Resource links including but not limited to, contact information for Poison Control and the state cannabis regulator	79%	14%	5%
Notification that the product has been recalled, if applicable	88%	8%	3%
The lab testing results for the product, including: Passing results confirmation, official lab result document, lab name and license number that performed the testing, and date tested	89%	7%	3%

However, detailed laboratory testing documentation, expanded cannabinoid and terpene profiles, supply chain verification, and interactive regulatory information are often inaccessible or impractical to communicate directly through standard packaging and labeling formats. As such, state-issued QR code-enabled transparency systems may function as mechanisms for extending informational accessibility beyond the physical and regulatory constraints of conventional cannabis labeling requirements.

Collectively, these findings may suggest that cannabis consumers perceive meaningful utility in detailed product-level transparency systems, particularly for information related to regulatory compliance, laboratory verification, and product authentication. From the perspective of information asymmetry, these findings support the proposition that consumers place substantial value on mechanisms capable of reducing uncertainty surrounding product legitimacy, composition, and regulatory oversight.

Attitudes About the QR Code

Upon being exposed to the state-issued QR code and landing page video demonstration, respondents were asked if they agree or disagree with statements as shown in Table 2, below.

Table 2. Agreement with QR code Statements

	I agree	I do not agree nor disagree	I disagree
The state-issued QR code functionality makes me more likely to buy from a licensed dispensary as opposed to an illicit source.	90%	8%	2%
The state-issued QR code functionality makes me more likely to buy the product again	82%	16%	2%
The state-issued QR code functionality makes me feel more connected to the product or brand	77%	19%	4%
The state-issued QR code functionality makes me feel more protected by my state cannabis regulator	100%	-	-
The state-issued QR code functionality makes me feel more confident in my state's legal cannabis market	89%	10%	1%
The state-issued QR code functionality helps me understand the product safeguards and standards in place to protect cannabis consumers	91%	8%	1%

Respondents demonstrated overwhelmingly positive beliefs regarding the broader institutional and behavioral implications of the state-issued QR code transparency system. **Nearly 90% of respondents agreed that the QR code functionality made them more likely to purchase cannabis products from a licensed dispensary rather than an illicit source**, while 88.8% reported that the system increased confidence in their state's legal cannabis market. Similarly, over 91% agreed that the QR code functionality improved understanding of the safeguards and standards in place to protect cannabis consumers. Respondents also reported that the QR code system increased perceived connection to the product or brand (77%) and increased the likelihood of purchasing the product again (81.8%).

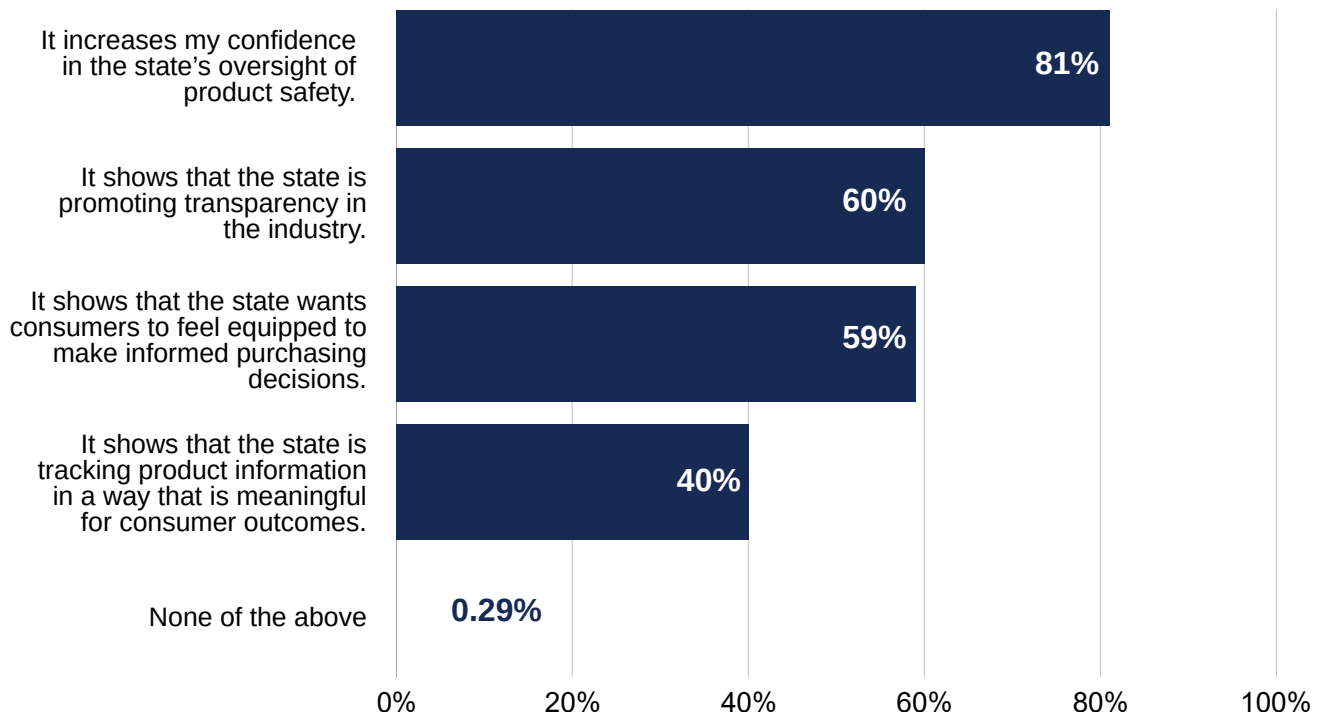
Most notably, 100% of respondents agreed that the state-issued QR code functionality made them feel more protected by their state cannabis regulator.

Within large-scale consumer survey research, particularly among a sample exceeding 3,000 respondents, complete or near-complete alignment on attitudinal measures is exceptionally rare. As such, this finding may reflect an unusually strong degree of consensus regarding the perceived consumer protection and institutional oversight value communicated through the digital transparency systems issued by the state. Additionally, the finding that all respondents agreed that the state-issued QR code functionality increased feelings of protection from their state cannabis regulator may be particularly important from the perspective of institutional trust formation within emerging regulated cannabis markets. Legal cannabis systems operate within environments where consumers are often unable to directly observe underlying regulatory processes such as laboratory testing, product tracking, licensing enforcement, or recall monitoring. Under such conditions, consumer-facing transparency systems may function not only as informational tools, but also as visible demonstrations of active regulatory oversight and institutional participation. In this sense, a state-issued QR code infrastructure may serve as a mechanism through which abstract regulatory processes become materially visible to consumers at the point of purchase. This visibility may strengthen perceptions that the regulated market is accountable, monitored, and oriented toward consumer protection, thereby increasing broader trust in the legitimacy and credibility of the legal cannabis marketplace.

From a theoretical perspective, these findings are consistent with signaling theory and broader frameworks related to information asymmetry in regulated markets. Importantly, many of these outcomes are not solely related to the informational content provided through the QR code landing page itself, but rather to what the existence of the transparency mechanism may communicate regarding regulatory participation, oversight quality, accountability, and institutional legitimacy. Under conditions where consumers cannot independently verify underlying product quality, testing rigor, or supply chain integrity, visible transparency infrastructure may function as an observable signal of compliance and regulatory engagement. As such, the findings suggest that state-issued QR code-enabled transparency systems may generate perceived value through at least two related pathways: first, by reducing uncertainty through expanded access to product-level information; and second, by communicating broader signals of legitimacy, consumer protection, and market trustworthiness independent of whether consumers fully engage with the underlying informational content.

All 3,061 participants who agreed that a state-issued QR code on cannabis packaging and its linked landing page made them feel more protected by their state cannabis regulator were then asked to elaborate on their response.

Figure 1. You responded that you agreed that having a state-issued QR code on cannabis packaging, and its resulting landing page information makes you feel more protected by your state cannabis regulator. Please elaborate on this statement by selecting from the following



Among respondents who reported that the state-issued QR code functionality made them feel more protected by their state cannabis regulator, the most frequently endorsed explanation was that the system increased confidence in the state's oversight of product safety (81.4%). Additional respondents reported that the QR code system signaled that the state was promoting transparency within the cannabis industry (59.8%), wanted consumers to feel equipped to make informed purchasing decisions (58.8%), and was tracking product information in ways meaningful for consumer outcomes (40.3%).

These findings reiterate that consumers may perceive state-issued QR code-enabled transparency systems not only as product-level information tools, but also as visible demonstrations of active regulatory engagement within the legal cannabis market. Importantly, the strongest endorsement was tied specifically to confidence in state oversight of product safety, suggesting that transparency infrastructure may strengthen perceptions of institutional credibility and consumer protection within emerging regulated cannabis systems.

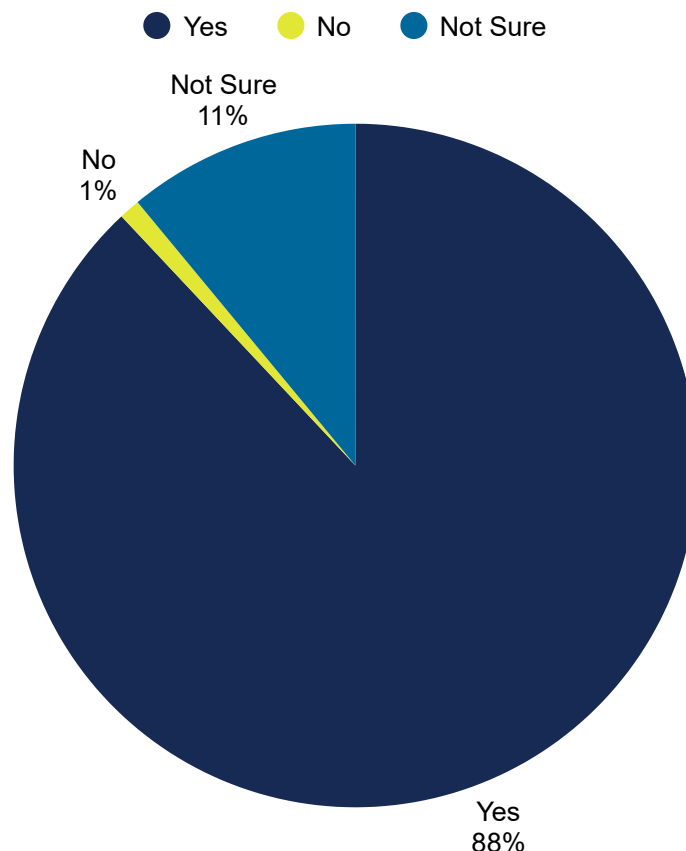
QR Codes as Product Authentication and Legitimacy Signals

A substantial majority of respondents (88%) reported that access to the state-issued QR code information would help them differentiate regulated cannabis products from unregulated products, while only 1% reported that it would not and 11% remained unsure. Importantly, respondents did not merely report valuing the informational content accessible through the state-issued QR code system; they also appeared to perceive the state-issued QR code functionality itself as a mechanism for authenticating product legitimacy and regulatory oversight. This finding may help contextualize the broader willingness to pay analyses presented later in the study, as consumers may derive value not only from expanded information accessibility, but also from increased confidence that products originate from regulated market channels.

These findings suggest that consumers may perceive state-issued QR code-enabled transparency systems as useful tools for identifying products participating within regulated cannabis supply chains.

Figure 2. QR Codes as Product Authentication and Legitimacy Signals

Would having access to this information via a state-issued QR code help you differentiate between regulated (e.g., produced and sold legally by licensed businesses and compliant with public health and safety standards) and unregulated cannabis products (e.g., produced and sold on the illicit market and not compliant with public health and safety standards)?



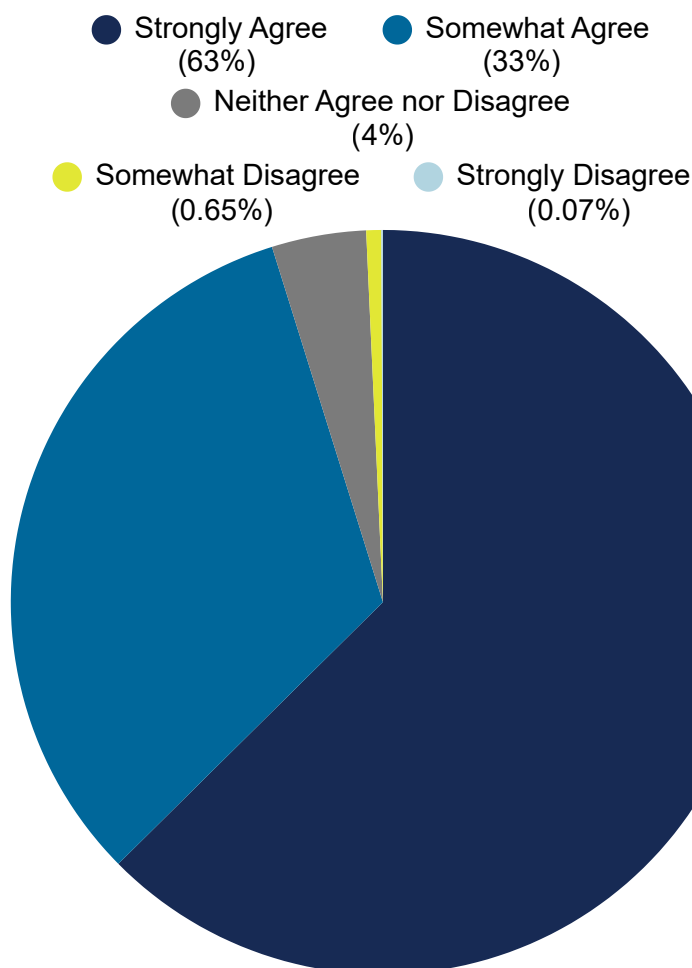
Support for Standardized State-Issued QR Code Transparency

Respondents demonstrated support for standardized implementation of state-issued QR code transparency systems across cannabis product categories. Specifically, 62.6% of respondents strongly agreed and an additional 32.6% somewhat agreed that the same level of state-issued QR code accessible information should be applied universally across cannabis products regardless of product type, representing over 95% total agreement. In contrast, fewer than 1% of respondents expressed specific disagreement with the statement.

Figure 3. Support for Standardized QR code Transparency

Do you **agree** or **disagree** with the following statement:

I believe that the state-issued QR code should be applied to every cannabis product, with the same level of information accessible to consumers, regardless of product type.



Notably, respondents' preference for making this information available on every product suggests that consumers value consistency as much as the information itself. Rather than viewing transparency as a product-specific feature, respondents appeared to view it as a baseline expectation of the regulated marketplace. This finding suggests that the effectiveness of state-issued digital transparency systems may depend not only on the quality of the information provided, but also on the consistency and reliability with which that information is delivered across products.

These findings suggest that consumers may perceive detailed product transparency as an expected standardized feature of regulated cannabis markets rather than a niche or product-specific enhancement. Importantly, the findings may indicate broad consumer preference for consistency in access to product, laboratory, and regulatory information across purchasing contexts and product categories.

Inferential Statistics - Hypothesis Testing of State-Issued QR Code Transparency Valuation

To conduct inferential statistics related to the perceived value of QR codes, we used three key survey elements:

Past-Month Cannabis Spending. After providing consent to participate in the survey, each participant began the survey reporting their total, on average past-month grams and expenditures per product type, per source in Cannabis Public Policy Consulting's proprietary cannabis demand block survey logic. Expenditures were aggregated to identify average past-month cannabis spending by source. To minimize the influence of extreme outliers on statistical analysis without removing the data points entirely, winsorizing was applied to the 95th percentile.

State-Issued QR Code Landing Page Stimulus. Participants were shown a cannabis product both with and without a purported state-issued QR code. Respondents were then asked to identify the product with the QR code for an initial comprehension check. As discussed previously, respondents then viewed a video demonstration of the state-issued interactive QR code landing page, as provided by Metrc, containing product verification information, laboratory testing data, cannabinoid and terpene profiles, licensing information, and public health resources with a corresponding text description of these features. Participants viewed the demonstration video and then completed a series of 5-point Likert scale items assessing perceived trust in the information, product safety, product quality, confidence in product authenticity, and perceived informational adequacy (i.e., the extent to which they felt informed about the product information). The accompanying text description of the interactive informational features remained visible while participants completed these measures.

Willingness to Pay as Perceived Economic Valuation. To evaluate the perceived or hypothetical economic value of QR code-enabled transparency systems, the present study utilized willingness to pay (WTP) methodology grounded in behavioral economics. WTP measures the maximum amount an individual is willing to sacrifice to obtain a specific good, service, feature, or outcome. In behavioral research, WTP is commonly used to operationalize value formation under conditions involving tradeoffs between cost and perceived utility.¹⁵

Importantly, WTP measures *do not* imply that reported monetary values will translate directly into real-world purchasing behavior under all conditions and tradeoffs, nor did this study seek to identify a price valuation for a state-issued QR code product. Rather, WTP is used within this study to provide insight into the relative subjective value consumers assign to a given feature or intervention. Within the context of the current study, WTP was used to assess whether consumers perceived state-issued QR code-enabled transparency features as sufficiently valuable.

Respondents were presented with a prompt to provide the amount of USD that they would be willing to pay *in addition* to the product cost as reported for a product with a state-issued QR code and its detailed product information as described. Those not willing to pay more than the listed price for a state-issued QR code and its detailed product information were prompted to provide "0" in the response box. To isolate the value respondents placed on the QR code and accompanying product information, the cannabis product was intentionally described without specifying product type, potency, brand, or other characteristics that could independently influence willingness to pay. The product was presented as costing \$11 per gram, reflecting an estimated average retail price across legal markets, using flower as the most broadly comparable per-gram pricing benchmark.

Primary Hypothesis Testing. The current study sought to test two initial hypotheses:

- **Hypothesis #1:** Past-month cannabis consumers would assign measurable perceived economic value to state-issued QR code-enabled cannabis product transparency systems, reflected through positive willingness to pay estimates.
- **Hypothesis #2:** Greater participation in illicit cannabis sourcing channels would be negatively associated with willingness to pay for state-issued QR code-enabled transparency features, whereas greater participation in regulated sourcing channels would be positively associated.

Exploring Differences in Willingness to Pay Among Key Consumer Subpopulations

Among the 1,886 respondents included in the WTP analytic sample, the mean additional amount respondents reported being willing to pay for QR code-enabled transparency features, beyond the baseline cannabis product cost, was \$3.48 (Median = \$2.00). Consistent with the study's first hypothesis, respondents assigned positive economic value to state-issued QR code-enabled cannabis product transparency systems, as reflected by their willingness to pay an average premium above the product's listed price.

Initial analyses examined whether WTP for state-issued QR code-enabled cannabis product information varied across key consumer subpopulations commonly associated with differences in cannabis purchasing behaviors and market participation patterns. Respondents were subset according to: (1) medical cannabis patient status, (2) legal market environment (medical-only versus adult-use and medical jurisdictions), and (3) self-reported frequency of cannabis consumption.

Because WTP responses exhibited non-normality and right-skewness, non-parametric Wilcoxon rank-sum statistical tests were employed to evaluate differences in distributions of WTP across consumer subgroups. Findings indicated statistically significant differences across all three observed groups ($p < .001$).

Registered medical cannabis patients demonstrated significantly greater median WTP for QR code-enabled product information relative to non-patient consumers. Similarly, respondents residing in medical-only jurisdictions reported significantly greater median WTP compared to respondents residing in adult use markets. Finally, weekly cannabis consumers demonstrated significantly greater median WTP relative to daily consumers.

Table 3. Mean and Median Willingness to Pay by Patient Status

Patient Status	Mean WTP	Median WTP
Not a Patient	\$2.36	\$1
Registered Patient	\$3.95	\$3

Table 4. Mean and Median Willingness to Pay by State Cannabis Legalization Status

Legal Jurisdiction	Mean WTP	Median WTP
Residing in Adult Use + Medical State	\$3.41	\$2
Residing in Medical Only State	\$3.75	\$3

Table 5. Mean and Median Willingness to Pay by Cannabis Use Frequency

Cannabis Use Frequency	Mean WTP	Median WTP
Daily	\$3.21	\$2
Weekly	\$3.82	\$3

These findings suggest that consumer valuation of state-issued QR code-enabled transparency systems may vary meaningfully according to market context, regulatory exposure, and consumption behaviors. While daily consumers may interact with products more, weekly consumers may deliberate more during purchasing or engage more cognitively with product attributes. Daily consumers may have normalized purchasing behaviors where additional information may not be valued as much. Registered patients may be more likely to value more information given the consumption of products for medical purposes. For many patients, their conditions may make them vulnerable to adverse reactions or other negative health consequences that additional information may help them avoid.

The observed subgroup differences suggest that broader market participation patterns may influence how consumers economically value transparency infrastructure. However, because cannabis consumers often engage across multiple purchasing channels simultaneously (e.g., diversify sources), subgroup comparisons alone are insufficient to disentangle the independent effects of sourcing behaviors, frequency of use, patient status, and demographic characteristics.

Accordingly, multivariable regression models were estimated to examine the relationship between cannabis market participation and willingness to pay while controlling for relevant covariates.

Multivariable Linear Regression Models

Linear Regression Model 1. Dealer vs. Licensed Spending and WTP

To test our second hypothesis, we employed a linear regression. A linear regression model is a supervised machine learning algorithm and statistical method used to predict a continuous, numerical dependent variable based on one or more independent predictor variables. These models directly estimate expected change in the dependent variable associated with a one-unit change in a predictor. For the following linear regressions, our continuous dependent variable is reported willingness to pay for the state-issued QR code-enabled product information ($n = 1,886$).

Linear regression was selected because the primary objective of the analysis was to estimate the independent directional and marginal associations between multiple predictor variables and variation in a continuous willingness to pay outcome while controlling for relevant covariates. This approach additionally allowed for interpretable estimation of effect magnitude across behavioral and perceptual predictors. To ensure that a linear regression was the appropriate analysis, we conducted standard diagnostic tests to verify the assumptions of linearity, independence of errors, homoscedasticity, and residual normality, as well as screening for multicollinearity. Provided that the data was nonparametric and had right skewness, we applied a square-root transformation to normalize the data.

Our first linear regression model tested our second hypothesis, if greater participation in illicit cannabis sourcing channels would be *negatively* associated with willingness to pay for state-issued QR code-enabled transparency features, and greater participation in regulated cannabis sourcing channels would be positively associated. To test this, our model included past-month licensed cannabis spending (e.g., purchased from a licensed store or delivery from a licensed store) and past-month dealer cannabis spending (e.g., purchased from a dealer) alongside all standard geographic, socioeconomic, and demographic variables and the three key subpopulation categories identified in the previous analysis. All regressions used variable reference points that reflected the average respondent in our sample.

The model found four predictors outside of our control variables. Holding all geographic, socioeconomic, and demographic controls constant, our initial regression model identified total dealer spending as having a highly significant positive association with the square-root transformed willingness to pay outcome ($B = 0.020$, $p < .001$), indicating that greater dealer spending was associated with higher willingness to pay. Importantly, total licensed spending remained non-significant ($B = -0.00005$, $p = .764$). That is, there is no evidenced statistical relationship between spending in licensed cannabis stores and willingness to pay for the QR code. **These findings reject our hypothesis that dealer purchasing would be negatively related to willingness to pay, and licensed purchasing would be positively associated.**

Patient status was the most robust predictor of the transformed outcome, showing a significant positive effect on the square root of willingness to pay for the QR code-enabled product information ($B = 0.525$, $p < .001$). **In other words, being a registered medical cannabis patient has the largest, positive statistical influence on willingness to pay for the state-issued QR code system in this initial model.** While less robust of an effect size, both monthly use ($B = 0.199$, $p = .004$) and weekly use ($B = 0.182$, $p < .001$) significantly predicted higher values on the square root of willingness to pay, compared to daily use.

Because willingness to pay was square-root transformed to satisfy the assumptions of linear regression, the coefficients are estimated on the transformed scale rather than directly in dollars. Consequently, the relationship should not be interpreted as a fixed dollar increase across all consumers (i.e., not a 1:1 increase). Instead, consumers with higher dealer spending are predicted to exhibit larger increases in willingness to pay than consumers with lower dealer spending. For example, the model suggests that QR code-enabled product information may increase willingness to pay by only about \$2 among consumers who spend relatively little with dealers, whereas consumers who spend substantially more with dealers may be willing to pay upwards of \$10 for the same transparency features.

While licensed cannabis stores reflect most of the regulated market where cannabis consumers would be provided the option of a product with a state-issued QR code, it is not the only source. Our second model explored if similar findings would be identified when examining *markets* as opposed to individual *sources*.

Linear Regression Model 2. Illicit vs. Regulated Market Spending and WTP

Our second model grouped sources into markets, wherein the true illicit market (e.g., not gray like gifting, or unregulated like homegrow) included past-month expenditures with dealers and purchased from friends and family. The regulated market grouped past-month expenditures from licensed stores, delivery from licensed stores, out-of-state licensed medical and adult use stores, and caregivers. We loaded these two variables into our model, replacing dealer and licensed spending.

The findings were consistent with the first model. Holding all geographic, socioeconomic, and demographic controls constant, **our second regression model identified total past-month illicit market spending demonstrated a highly significant, positive relationship with the transformed willingness to pay** ($B = 0.006$, $p < .001$), though effect size did decrease. Similar to our past model, the amount of spending in the regulated market did not explain anything about their willingness to pay for the state-issued QR code. Being a registered medical patient remained the most robust predictor of willingness to pay for the state-issued QR code in our model ($B = 0.529$, $p < .001$).

The market-based specification produced similar coefficient estimates and a modest improvement in overall model fit, supporting its use in subsequent analyses. However, the only modest improvement suggested that additional factors not captured by the current specification may also contribute to willingness to pay. Consistent with the study's conceptual framework, which theorized that transparency itself may hold economic value by reducing uncertainty and increasing consumer trust, we tested two additional hypotheses:

- **Hypothesis 3:** Post QR code exposure perceptions related to trust, quality, safety, informational adequacy, and confidence would be positively associated with willingness to pay for QR code-enabled transparency systems.
- **Hypothesis 4:** Perceptual evaluations elicited following exposure to the QR code system would account for substantial variation in willingness to pay beyond demographic and behavioral characteristics alone.

After exposure to the state-issued QR code-enabled landing page demo, respondents were asked to what extent, if at all, does the interactive, state-issued QR code and hosted information impact their perceptions related to trust in the information, safety of the product, quality of the product, informational adequacy, and confidence that the product was regulated. The responses were all Likert 5-item scale, with higher scores indicating more favorable perceptions. These five items demonstrated strong internal consistency (Cronbach's $\alpha = 0.83$). That is, the way people responded to each perception question was largely consistent and measured a common underlying construct. Accordingly, these responses were aggregated into a composite mean index assessing perceived trust, safety, quality, informational adequacy, and product confidence, with a range of 1-5, with higher values reflecting more favorable perceptions of regulatory transparency. We refer to this composite measure as the Regulatory Transparency Perception Index throughout the paper.

Linear Regression Model 3. Adding in the Regulatory Transparency Perception Index

After adding the Regulatory Transparency Perception Index to the model alongside illicit and regulated market spending and the control variables, overall model fit improved. A nested model comparison indicated that the expanded model explained significantly more variation in willingness to pay than Model 2 (ANOVA F-test, $p < .001$). These findings suggest that perceptions of regulatory transparency explain a meaningful portion of the variation in willingness to pay that was not captured by spending patterns or the demographic, geographic, and socioeconomic control variables alone.

The Regulatory Transparency Perception Index emerged as the most robust and significant predictor on the square root of willingness to pay ($B = 0.486$, $p < .001$), surpassing patient status ($B = 0.442$, $p < .001$). Importantly, the illicit market spending relationship remained positive and significant ($B = 0.006$, $p < .001$) with coefficient (e.g., estimated magnitude of the relationship) largely unchanged, and the regulated market spending remained insignificant.

The findings suggest that state-issued QR code system may transform regulatory and product information into perceived consumer value. **Importantly, the economic value associated with the state-issued QR code system may not stem solely from the informational content itself, but rather from the extent to which the information alters perceptions related to product legitimacy.** The emergence of the Regulatory Transparency Perception Index as the strongest predictor of willingness to pay suggests that these perceptual evaluations may represent a key mechanism through which transparency infrastructure generates economic utility within regulated cannabis markets.

Put simply, the findings suggest that state-issued QR code-enabled transparency systems may convert perceived trust and transparency into measurable economic value that heavy illicit-market spending consumers are willing to pay for. More broadly, the findings suggest that standardizing and requiring this regulatory transparency may itself function as a value-generating attribute within regulated cannabis products.

The findings suggest that state-issued QR code-enabled transparency systems may convert perceived trust and transparency into measurable economic value that heavy illicit-market spending consumers are willing to pay for.

Given the non-linear relationship between illicit market spending and willingness to pay observed in our fully adjusted model, we present the figure and table below to facilitate interpretation. Predicted willingness to pay was estimated at \$5 increments of illicit market spending while holding all other covariates at their sample mean values.

Figure 4. Model-Predicted WTP at \$5 Increments of Average Consumer Past-Month Illicit Market Spending

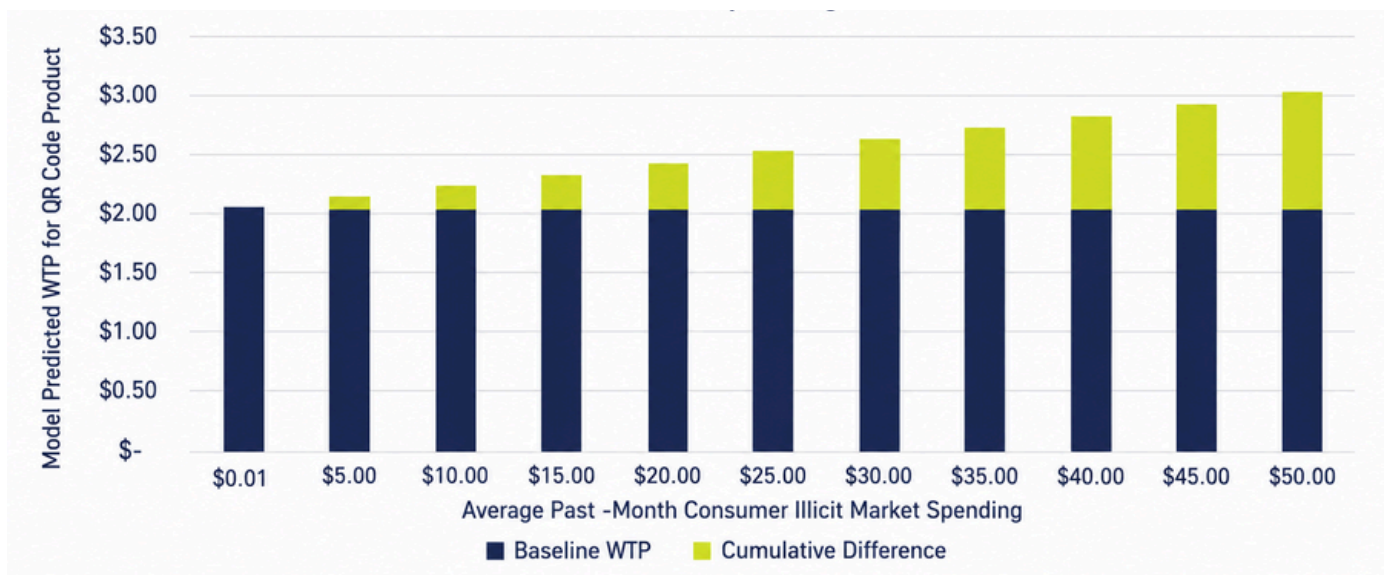


Table 6. Estimated Willingness to Pay for a QR Code by Illicit Cannabis Market Spending

WTP	Average Consumer Unregulated Spending	Difference in WTP	Interpretation
\$2.10	\$0.01	-	The model predicts that consumers spending approximately \$0 in the illicit market have a willingness to pay of \$2.10 for the QR code.
\$2.19	\$5.00	+\$0.0880	Increasing illicit market spending from \$0 to \$5 is associated with a \$0.088 increase in predicted willingness to pay, from \$2.10 to \$2.19.
\$2.28	\$10.00	+\$0.0899	Increasing illicit market spending from \$5 to \$10 is associated with a \$0.090 increase in predicted willingness to pay, from \$2.19 to \$2.28.
\$2.37	\$15.00	+\$0.0917	Increasing illicit market spending from \$10 to \$15 is associated with a \$0.092 increase in predicted willingness to pay, from \$2.28 to \$2.37.
\$2.46	\$20.00	+\$0.0936	Increasing illicit market spending from \$15 to \$20 is associated with a \$0.094 increase in predicted willingness to pay, from \$2.37 to \$2.46.
\$2.56	\$25.00	+\$0.0954	Increasing illicit market spending from \$20 to \$25 is associated with a \$0.095 increase in predicted willingness to pay, from \$2.46 to \$2.56.
\$2.65	\$30.00	+\$0.0972	Increasing illicit market spending from \$25 to \$30 is associated with a \$0.097 increase in predicted willingness to pay, from \$2.56 to \$2.65.
\$2.75	\$35.00	+\$0.0990	Increasing illicit market spending from \$30 to \$35 is associated with a \$0.099 increase in predicted willingness to pay, from \$2.65 to \$2.75.
\$2.85	\$40.00	+\$0.1008	Increasing illicit market spending from \$35 to \$40 is associated with a \$0.101 increase in predicted willingness to pay, from \$2.75 to \$2.85.
\$2.96	\$45.00	+\$0.1026	Increasing illicit market spending from \$40 to \$45 is associated with a \$0.103 increase in predicted willingness to pay, from \$2.85 to \$2.96.
\$3.06	\$50.00	+\$0.1044	Increasing illicit market spending from \$45 to \$50 is associated with a \$0.104 increase in predicted willingness to pay, from \$2.96 to \$3.06.

Discussion and Interpretation of Findings

Cannabis consumers often make purchasing decisions using imperfect information regarding product quality, safety, and regulatory compliance.¹⁷ Unlike many conventional consumer goods, important product characteristics, including cannabinoid composition, laboratory testing validity, contamination risk, and regulatory compliance, are not directly observable at the point of purchase. These information gaps often have important public health implications, particularly because cannabis is used by many individuals to manage symptoms associated with a wide range of medical conditions and because regulated and illicit products often coexist within the same marketplace.¹⁸ Although regulated cannabis systems seek to reduce uncertainty through labeling requirements and mandatory product testing, conventional packaging can communicate only a limited amount of product and regulatory information. The findings of the present study suggest that consumers perceive substantial value in state-issued QR code transparency systems that extend access to detailed product-level and regulatory information beyond the constraints of traditional labeling.

The findings suggest that consumers are not responding solely to the informational content accessible through the state-issued QR code landing page. Across multiple descriptive measures, respondents consistently reported that the state-issued QR code functionality increased confidence in the legal cannabis market, improved understanding of consumer safeguards, and strengthened perceptions of protection from state cannabis regulators.

All respondents agreed that the state-issued QR code system made them feel more protected by their state cannabis regulator, an exceptionally rare level of alignment within large-scale consumer survey research.

Particularly notable was the finding that all respondents agreed that the state-issued QR code system made them feel more protected by their state cannabis regulator, an exceptionally rare level of alignment within large-scale consumer survey research. Collectively, these findings suggest that consumers may interpret state-issued QR code-enabled transparency systems as visible demonstrations of active regulatory oversight and accountability within legal cannabis markets.

In this sense, the state-issued QR code infrastructure appears to function through two related pathways. First, respondents clearly valued the expanded access to laboratory testing information, cannabinoid and terpene profiles, recall notifications, licensing verification, and other product-level information not commonly accessible through standard packaging. Second, the existence of the transparency system itself appeared to communicate broader signals related to product legitimacy, regulatory participation, and institutional trustworthiness. The findings therefore suggest that transparency infrastructure may generate value not only because of the information it provides, but also because of what the system itself communicates to consumers regarding oversight and accountability.

This finding is further supported by respondents' overwhelming preference for standardization. Approximately 95% of respondents agreed that the same detailed information should be available for every cannabis product. From a signaling perspective, this preference is important because signals reduce uncertainty when they are consistent and reliable.

A standardized, state-issued QR code system ensures that consumers can expect the same type and depth of regulatory information regardless of the product they purchase, strengthening the credibility of the signal and its ability to foster trust. In contrast, inconsistent implementation across products or manufacturers may weaken the signal by making it more difficult for consumers to distinguish verified regulatory information from voluntary marketing claims.

The findings suggest that state-issued QR code-enabled transparency systems may convert perceived trust and transparency into measurable economic value among cannabis consumers.

The willingness to pay analyses further suggest that these perceptions may possess measurable economic relevance. Respondents reported positive willingness to pay estimates for products containing state-issued QR code-enabled transparency features, indicating that consumers assigned economic value to the system beyond the baseline product itself. Most importantly, the perception index related to trust, safety, informational adequacy, and product legitimacy emerged as the most robust predictor of willingness to pay within the fully specified regression model. Put simply, the findings suggest that state-issued QR code-enabled transparency systems may convert perceived trust and transparency into measurable economic value among cannabis consumers.

One of the most notable findings of the present study was that greater participation in illicit cannabis sourcing environments was positively associated with willingness to pay for state-issued QR code-enabled transparency systems, while spending within regulated market channels demonstrated no meaningful statistical relationship. At face value, this finding may appear counterintuitive. However, consumers who routinely purchase cannabis through licensed retail environments are already exposed to baseline levels of product transparency through standardized labeling, cannabinoid disclosures, laboratory testing indicators, and other regulatory compliance signals. As a result, additional transparency mechanisms may provide comparatively smaller incremental gains in perceived value. Conversely, consumers operating within illicit or informal sourcing environments may experience substantially greater uncertainty regarding product legitimacy, testing validity, contamination risk, and product composition. **Because these consumers are less likely to encounter standardized verification systems during routine purchasing experiences, state-issued QR code-enabled transparency infrastructure may provide comparatively larger gains in confidence, certainty, and perceived product trustworthiness.**

This pattern may be conceptually consistent with the economic principle of diminishing marginal utility, wherein the incremental value derived from an additional unit of a good or service decreases as baseline access to that good or service increases.¹⁶ Applied to the present findings, consumers already embedded within regulated purchasing environments may experience smaller marginal gains from additional transparency and authenticity signals because many foundational informational needs are already partially satisfied. In contrast, consumers sourcing products through less transparent environments may remain on the steeper portion of the utility curve, where additional transparency and authenticity generates comparatively greater perceived value.

These findings should not be interpreted to suggest that illicit market consumers inherently value transparency more broadly than regulated market consumers.

Rather, the findings suggest that the relative marginal value of transparency infrastructure may differ according to consumers' baseline exposure to trusted product information and regulatory oversight mechanisms. From a behavioral economics perspective, state-issued QR code-enabled transparency systems may therefore function not merely as passive informational content, but as economically meaningful signals capable of reducing uncertainty within cannabis purchasing environments.

More broadly, the findings of the present study suggest that state-issued QR code-enabled transparency systems may represent more than a technological enhancement to cannabis packaging. Rather, state transparency infrastructure itself may function as a mechanism through which regulated cannabis markets communicate legitimacy, accountability, and consumer protection to consumers operating under conditions of informational uncertainty. Consumers reporting greater participation in illicit sourcing environments consistently demonstrated higher willingness to pay for the state-issued QR code-enabled transparency functionality, while regulated market spending remained unrelated to willingness to pay across models. Combined with the finding that the Regulatory Transparency Perception Index emerged as the most robust predictor of willingness to pay ($M = 4.46/5.00$), the results suggest that the economic value associated with the state-issued QR code system may stem not only from informational accessibility itself, but from the extent to which the system increases perceptions related to trust, safety, product legitimacy, and regulatory oversight. Taken together, these findings suggest that state-issued QR code-enabled transparency systems may help translate institutional trust and informational accessibility into measurable perceived economic value among cannabis consumers. As legal cannabis markets continue to mature and compete alongside illicit market channels, standardizing transparency infrastructure across regulated products may represent one potential mechanism for strengthening consumer confidence and engagement within regulated purchasing environments.

Recommendations

Regulators and industry stakeholders should strongly consider implementing and standardizing state-issued QR code-enabled transparency systems across regulated cannabis products alongside large-scale consumer education and awareness campaigns. Because the effectiveness of transparency infrastructure depends in part on consumer understanding and engagement, implementation efforts would likely benefit from public-facing educational initiatives explaining the purpose, functionality, and informational utility of the state-issued QR code system. Such campaigns may increase awareness regarding laboratory testing verification, product authentication, recall notifications, and other regulatory safeguards accessible through the transparency infrastructure.

To maximize perceived legitimacy and institutional trust, regulators implementing the state-issued QR code across cannabis products should consider maintaining visible regulatory participation within transparency infrastructure, including state-issued verification language, regulator-linked landing pages, or standardized compliance authentication systems. Transparency systems should also prioritize usability, readability, and consumer accessibility, particularly given the complexity of laboratory testing data and cannabinoid information presented to consumers.

Finally, future research should evaluate the real-world behavioral and market impacts of state-issued QR code implementation using longitudinal and quasi-experimental designs. Prior to implementation, researchers should establish baseline measures among past-month cannabis consumers related to cannabis sourcing behaviors, perceptions of trust and safety, awareness of product safeguards, and purchasing patterns across regulated and illicit market channels. Following implementation, respondents should be recontacted across multiple follow-up timepoints to assess whether exposure to state-issued QR code-enabled transparency systems is associated with changes in purchasing behaviors, trust in regulated markets, and consumer engagement with regulated retail systems. Future evaluations should also specifically examine whether state-issued QR code-enabled transparency systems influence participation in illicit versus regulated cannabis markets. Given that greater illicit market participation emerged as a positive predictor of willingness to pay for the transparency functionality within the present study, evaluating whether standardized transparency infrastructure meaningfully shifts consumer spending patterns toward regulated channels represents a particularly important area for future research.

Limitations

Several limitations should be considered when interpreting the findings of the present study. First, the data are derived from a single cross-sectional non-probability-based sample of past-month cannabis consumers residing in legal cannabis jurisdictions across the United States. As such, the findings should not be interpreted as nationally representative estimates of all cannabis consumers or U.S. adults more broadly. Rather, the findings are most appropriately interpreted as evidence of relationships and perceptual patterns observed within the present sample.

Second, the study represents a single observational investigation examining perceptions and behavioral economic valuation of state-issued QR code-enabled cannabis transparency systems. Although the findings were *highly* consistent across multiple descriptive and inferential analyses, replication across additional samples, jurisdictions, and research designs is warranted to further evaluate the robustness and generalizability of the observed relationships.

Third, the final sample was skewed toward individuals with current participation in medical cannabis systems. This pattern is common in convenience sampling approaches recruiting across adult-use *and* medical cannabis jurisdictions and may have influenced the observed findings, particularly given that patient status emerged as one of the strongest predictors of willingness to pay for state-issued QR code-enabled transparency systems.

Further, respondents evaluated a specific state-issued QR code landing page demonstration developed for the present study. Consumer responses may therefore be partially influenced by the presentation, usability, or design characteristics of the demonstrated interface rather than QR code functionality in the abstract. However, this bias is rather unavoidable in observational research like the current study.

Additionally, respondents reported relatively low average spending through dealer or other illicit market channels compared with regulated market purchases. This distribution may partially reflect the elevated proportion of medical patients within the sample and could influence the estimated relationship between illicit market participation and willingness to pay for state-issued QR code transparency infrastructure. Nevertheless, despite the relatively low levels of illicit market spending observed, illicit market spending remained a statistically significant predictor of willingness to pay across all model specifications, suggesting that meaningful variation remained within the sample. At the same time, because the study sampled only individuals legally eligible to purchase cannabis within their jurisdiction of residence, the relatively low levels of reported illicit market spending are likely to reflect purchasing patterns within legal cannabis markets rather than solely an artifact of the sample composition.

Finally, while the present findings provide evidence regarding consumer perceptions, valuation, and self-reported responses to state-issued QR code-enabled transparency systems, the study did not evaluate real-world implementation or observed purchasing behavior. Experimental studies, particularly discrete choice experiments and post-implementation evaluations within operational cannabis markets would substantially strengthen understanding of whether these observed perceptual and willingness to pay relationships translate into measurable behavioral or market outcomes under real-world conditions.

End notes

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