“Autonomous stores: How levels of in-store automation affect store patronage”, Journal of Retailing, Benoit, Sabine, Birgit Altrichter, Dhruv Grewal, and Carl-Philip Ahlbom (2024),

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Retailing in Digital Economy (IBM 6300)

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DEFINITIONS

Autonomous retail/store, Unstaffed stores - are accessible retail outlets that can be operated by the retailer without human presence available to monitor or support shoppers. (Amazon Go)

Retail technology - are how to “check-out” from a store, other tech like digital prices. Is it done through an app, self check out, or different means.

Retail/Store patronage - What store you go to most often.

DIGITAL ABSTRACT

Access

Assistance

Transaction

Verification

PURPOSE OF THE STUDY

- Identify features of autonomous stores that encourage customer patronage
- Retain existing customers
- Attract new customers
- Understand customer behavior and shopping tendencies
- What variables are customers is willing to compromise?
  - Access, Assistance, Transaction, Verification
  - Autonomy, Convenience, Safety

CONTRIBUTION OF THE STUDY

- What can be done to enhance the customer experience?
- What can we identify for features of autonomous stores that customers would accept?
- The main Concepts of Access, Assistance, Transaction, and Verification convenience
- What are the Trade-offs: Autonomy, Convenience, Safety

BACKGROUND

- Where do we see these stores?
- Technological advancements vs. customer preference
- Gaps in understanding customer patronage
- What else can be done to help gain consumer patronage

OUR NUMBERS

Hypothesis 1

- Convenience dimensions (check-in, staff support, check-out, basket verification) affect store patronage

Hypothesis 2

- Perception of convenience, autonomy, and safety mediates impact on patronage

Hypothesis 3

- Store location moderates the impact of convenience dimensions on patronage

METHOD

Study Design

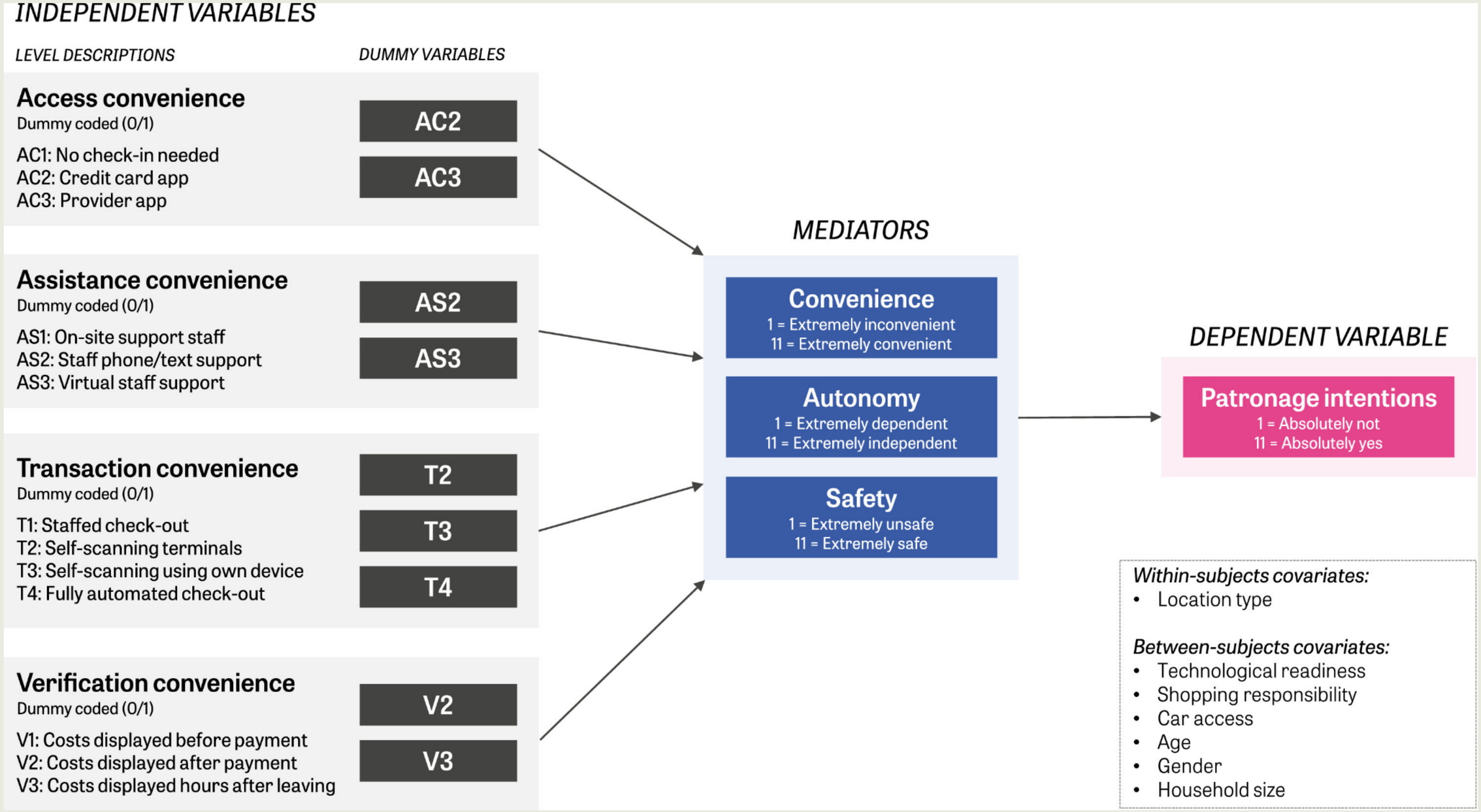
- Conjoint analysis through experimental design
- Animated videos simulating shopping scenarios
- Survey of 700 UK participants

Data Collection

- Rated videos on an 11-point scale
- Questions on demographics, personality traits, shopping habits
- 2100 usable observations

Data Analysis

- Hierarchical linear modeling
- Bayesian Markov chain Monte Carlo (MCMC) for indirect effects


INDEPENDENT VARIABLES
LEVEL DESCRIPTIONS
DUMMY VARIABLES
Access convenience
Dummy coded (0/1)
AC1: No check-in needed
AC2: Credit card app
AC3: Provider app
AC2
AC3
Assistance convenience
Dummy coded (0/1)
AS1: On-site support staff
AS2: Staff phone/text support
AS3: Virtual staff support
AS2
AS3
Transaction convenience
Dummy coded (0/1)
T1: Staffed check-out
T2: Self-scanning terminals
T3: Self-scanning using own device
T4: Fully automated check-out
T2
T3
T4
Verification convenience
Dummy coded (0/1)
V1: Costs displayed before payment
V2: Costs displayed after payment
V3: Costs displayed hours after leaving
V2
V3
MEDIATORS
Convenience
1 = Extremely inconvenient
11 = Extremely convenient
Autonomy
1 = Extremely dependent
11 = Extremely independent
Safety
1 = Extremely unsafe
11 = Extremely safe
DEPENDENT VARIABLE
Patronage intentions
1 = Absolutely not
11 = Absolutely yes
Within-subjects covariates:
• Location type
Between-subjects covariates:
• Technological readiness
• Shopping responsibility
• Car access
• Age
• Gender
• Household size

Descriptive statistics for key variables.

Variable	Level measured	N	Mean/%	SD	Min/Max
Dependent variable					
Store patronage	Within-subjects	2100	7.11	3.17	1/11
Mediators					
Convenience	Within-subjects	2100	8.20	2.70	1/11
Autonomy	Within-subjects	2100	8.37	2.50	1/11
Safety	Within-subjects	2100	7.66	2.64	1/11
Covariates					
Technological readiness	Between-subjects	700	4.24	.60	1.19/7
Shopping responsibility	Between-subjects	700	2.10	1.43	1/7
Shopping frequency	Between-subjects	700	3.34	.69	1/4
Car access	Between-subjects	700	74.9%	.	0/1
Customer age	Between-subjects	700	40.20	14.62	17/87
Gender (men vs. other)	Between-subjects	700	50.1%	.	0/1
Household size	Between-subjects	700	3.77	1.37	1/10

Demographic details of participants in conjoint study.

Variable	Label	Mean (SD)/%
Age	Age in years	40.20 (14.62)
Gender	Male	50.1%
	Female	49.5%
	Unspecified	0.4%
Location	Urban	36.7%
	Suburban	45.0%
	Rural	18.3%
Education level	Up to secondary school	11.0%
	Higher or secondary education:	17.9%
	College or university	50.6%
	Post-graduate degree	19.9%
	Prefer not to say	0.7%

Notes: The total percentages for the education level do not add up to exactly 100.0% due to rounding.

FORMULA 1

$$
\begin{aligned}
\text{Patronage}_{ij} = {} & \gamma_{00} + \gamma_{10}\text{AC}_{2ij} + \gamma_{20}\text{AC}_{3ij} + \gamma_{30}\text{AS}_{2ij} \\
& + \gamma_{40}\text{AS}_{3ij} + \gamma_{50}\text{T}_{2ij} + \gamma_{60}\text{T}_{3ij} + \gamma_{70}\text{T}_{4ij} \\
& + \gamma_{80}\text{V}_{2ij} + \gamma_{90}\text{V}_{3ij} + \gamma_{100}\text{L}_{2ij} + \gamma_{110}\text{L}_{3ij} \\
& + \gamma_{01}\text{TRI}_{j} + \gamma_{02}\text{ShopResp}_{j} + \gamma_{03}\text{ShopFreq}_{j} \\
& + \gamma_{04}\text{Car}_{j} + \gamma_{05}\text{Age}_{j} + \gamma_{06}\text{Gender}_{j} \\
& + \gamma_{07}\text{HhSize}_{j} + u_{j} + e_{ij}
\end{aligned}
$$

They included variables related to technology readiness (TRIj), grocery shopping responsibilities (ShopRespj), and grocery shopping frequency (ShopFreqj). These variables addressed potential variance on variables outside the hypothesized research model.They also control for participants' age (Agej), gender (Genderj), household size (HhSizej), and access to a car (Carj).

FORMULA 2

$$
\begin{aligned}
\text{Mediator}_{k_{ij}} = {} & \gamma_{Mk\_00} + \gamma_{Mk\_10}AC_{2ij} + \gamma_{Mk\_20}AC_{3ij} \\
& + \gamma_{Mk\_30}AS_{2ij} + \gamma_{Mk\_40}AS_{3ij} + \gamma_{Mk\_50}T_{2ij} \\
& + \gamma_{Mk\_60}T_{3ij} + \gamma_{Mk\_70}T_{4ij} + \gamma_{Mk\_80}V_{2ij} \\
& + \gamma_{Mk\_90}V_{3ij} + \gamma_{Mk\_100}L_{ij} + \gamma_{Mk\_110}L_{3ij} \\
& + \gamma_{Mk\_01}TRI_j + \gamma_{Mk\_02}ShopResp_j \\
& + \gamma_{Mk\_03}ShopFreq_j + \gamma_{Mk\_04}Car_j \\
& + \gamma_{Mk\_05}Age_j + \gamma_{Mk\_06}Gender_j \\
& + \gamma_{Mk\_07}HhSize_j + u_{Y\_j} + e_{Y\_ij}
\end{aligned}
$$

They explored Convenienceij , Autonomyij , and Safetyij as mediating variables. For the first-stage model, we regress each potential mediator k (Convenience, Autonomy, Safety) on the same independent variables and covariates as in the main model, but we define each of the three mediators as the dependent variable instead (labeled k).

FORMULA 3

$$
\begin{aligned}
\text{Patronage}_{ij} = {} & \gamma_{Y\_00} + \gamma_{Y\_10}\text{AC}_{2ij} + \gamma_{Y\_20}\text{AC}_{3ij} \\
& + \gamma_{Y\_30}\text{AS}_{2ij} + \gamma_{Y\_40}\text{AS}_{3ij} + \gamma_{Y\_50}\text{T}_{2ij} \\
& + \gamma_{Y\_60}\text{T}_{3ij} + \gamma_{Y\_70}\text{T}_{4ij} + \gamma_{Y\_80}\text{V}_{2ij} \\
& + \gamma_{Y\_90}\text{V}_{3ij} + \gamma_{Y\_100}\text{L}_{2ij} + \gamma_{Y\_110}\text{L}_{3ij} \\
& \gamma_{Y\_120}\text{Convenience}_{ij} + \gamma_{Y\_130}\text{Autonomy}_{ij} \\
& + \gamma_{Y\_140}\text{Safety}_{ij} + \gamma_{Y\_01}\text{TRI}_{j} \\
& + \gamma_{Y\_02}\text{ShopResp}_{j} + \gamma_{Y\_03}\text{ShopFreq}_{j} \\
& + \gamma_{Y\_04}\text{Car}_{j} + \gamma_{Y\_05}\text{Age}_{j} + \gamma_{Y\_06}\text{Gender}_{j} \\
& + \gamma_{Y\_07}\text{HhSize}_{j} + u_{Y\_j} + e_{Y\_ij}
\end{aligned}
$$

They then regress Patronageij on all three mediators and the same independent variables and control variables to estimate the second-stage model

FORMULA 4

$$\text{Relative Indirect Effect}_{\text{IV}_t \rightarrow \text{Mediator}_k \rightarrow \text{patronage}} = \gamma_{\text{M}_{k\_t}} \times \gamma_{\text{Y}_k}$$

Multiplying the effect of each independent variable t on each mediator k and the effect of that specific mediator k on Patronageij allows us to estimate the indirect effects through each mediator, relative to the reference group in each factor

RESULT

Hypothesis 1

- We find important differences in the impacts of the convenience dimensions on store patronage (H1). For clarity, we report these results while controlling for relevant covariates (Equation 1), but all significant parameters remain significant whether we include the covariates or not.

Hypothesis 2

- To identify the underlying mechanisms that get activated when shoppers experience different types of convenience (H2), we examine a series of process mechanisms, in the form of participants' perception of convenience (M1), autonomy (M2), and safety (M3)

RESULT (CONT.)

Hypothesis 3

- To test H3, we assessed the main effects in a separate model in which location type is a moderator of each main effect we tested. However, none of these interactions was significant for any of the store convenience predictors, nor were the contrasts of any pairwise conditional effects between different locations significant. Thus, it appears that the convenience effects in the main model do not differ across types of locations, and we must reject H3.

Table 4
Main effect results with store patronage as dependent variable.

Fixed effects	Not.	Main Model			Main Model with Covariates		
		Estimate	SE	*p*	Estimate	SE	*p*
Intercept	γ_{00}	8.502	0.287	.000	3.920	1.019	.000
Level-1 (within-subjects)							
Access convenience							
Credit card (AC2)	γ_{10}	−0.600	0.134	.000	−0.598	0.133	.000
Provider app (AC3)	γ_{20}	−0.127	0.133	.340	−0.123	0.132	.350
Assistance convenience							
Staff phone/text support (AS2)	γ_{30}	−0.978	0.131	.000	−0.996	0.131	.000
Virtual staff support (AS3)	γ_{40}	−0.861	0.131	.000	−0.877	0.130	.000
Transaction convenience							
Self-scanning terminals (T2)	γ_{50}	0.255	0.303	.400	0.201	0.301	.504
Self-scanning own device (T3)	γ_{60}	0.048	0.307	.876	−0.040	0.304	.896
Fully automated check-out (T4)	γ_{70}	−0.262	0.338	.438	−0.353	0.335	.293
Verification convenience							
Costs after payment (V2)	γ_{80}	−0.321	0.170	.058	−0.324	0.168	.054
Costs after leaving store (V3)	γ_{90}	−1.367	0.168	.000	−1.351	0.167	.000
Location							
Traffic hub (L2)	γ_{100}				−0.316	0.126	.012
Rural (L3)	γ_{110}				0.180	0.126	.154
Level-2 (between-subjects)							
Technological readiness	γ_{01}				0.812	0.161	.000
Shopping responsibility	γ_{02}				−0.111	0.074	.132
Shopping frequency	γ_{03}				0.117	0.144	.419
Car access	γ_{04}				0.660	0.227	.004
Age	γ_{05}				−0.013	0.007	.067
Gender	γ_{06}				0.328	0.202	.106
Household size	γ_{07}				0.086	0.074	.247
Random effects							
Within-subjects residual	e_{ij}	4.095	0.155	.000	4.048	0.153	.000
Between-subject residual	u_j	5.357	0.364	.000	4.914	0.339	.000
Contrasts							
AC3 vs. AC2	$\gamma_{20}-\gamma_{10}$	0.473	0.127	.000	0.475	0.126	.000
AS3 vs. AS2	$\gamma_{40}-\gamma_{30}$	0.118	0.127	.354	0.119	0.126	.344
T3 vs. T2	$\gamma_{60}-\gamma_{50}$	−0.207	0.186	.266	−0.241	0.185	.193
T4 vs. T2	$\gamma_{70}-\gamma_{50}$	−0.517	0.236	.029	−0.554	0.235	.018
T4 vs. T3	$\gamma_{70}--\gamma_{60}$	−0.310	0.146	.034	−0.313	0.145	.031
V3 vs. V2	$\gamma_{90}-\gamma_{80}$	−1.046	0.128	.000	−1.027	0.127	.000

Notes: Reference levels are as follows: access convenience, no check-in needed (AC1); assistance convenience, on-site support staff (AS1); transaction convenience, staffed check-out (T1) verification convenience, costs displayed before payment (V1); and location, embedded in community (L1). Gender is coded as men (1) versus women and others (0).

IMPORTANCE PERCENTAGES

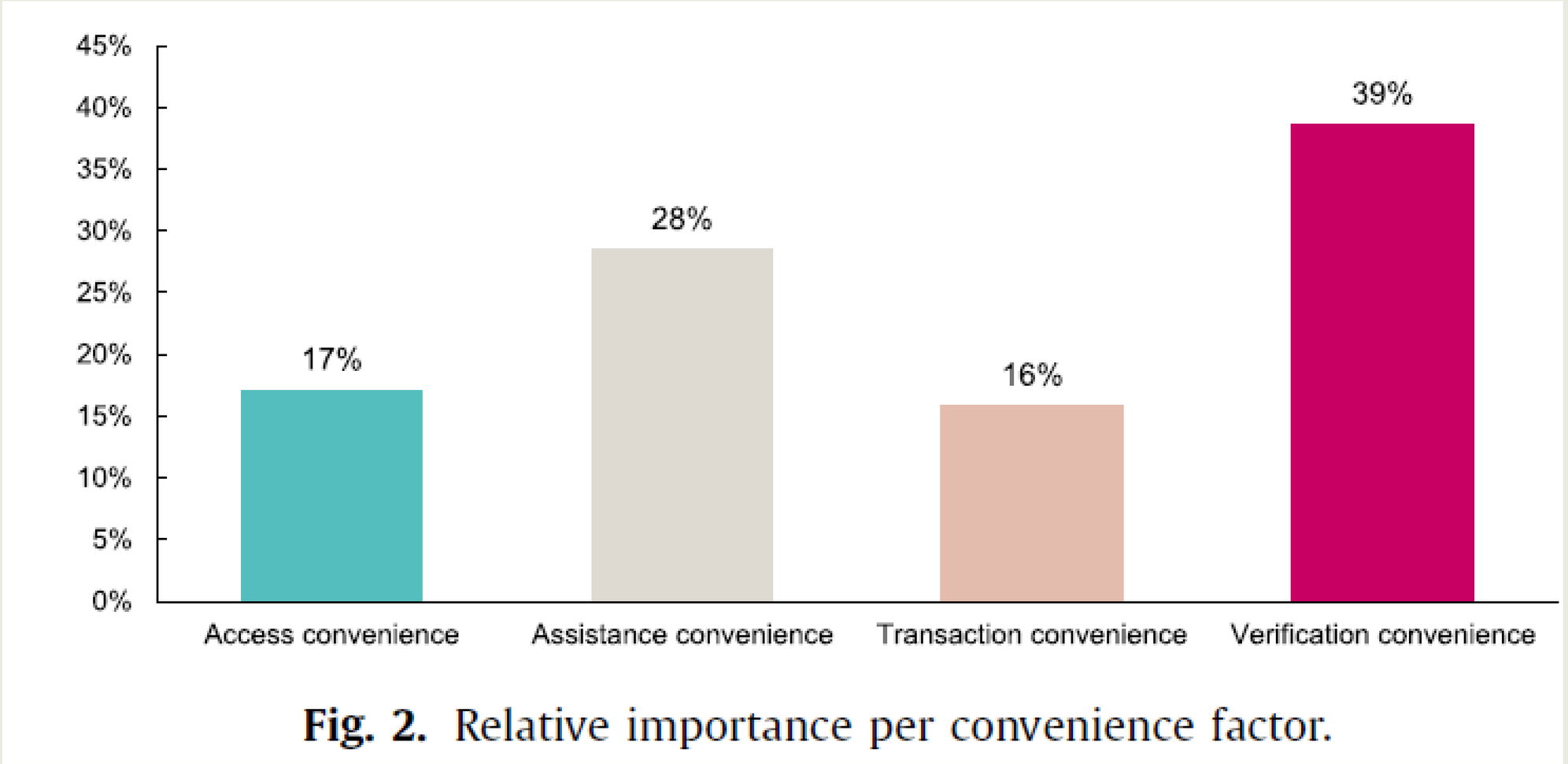


Fig. 2. Relative importance per convenience factor.

CONCLUSION

The novel technology that facilitates these relatively new shopping channels provides several competing options, but research into their market acceptance remains scarce and limited in scope. Therefore, retailers need more evidence and insights into which features are likely to encourage the highest patronage, in which locations, by which types of customers.

THERE ARE SEVERAL RECOMMENDATIONS FOR RETAILERS NEXT, BEFORE WE ELABORATE ON IMPLICATIONS FOR RESEARCH.

Indirect effects of different convenience factors on store patronage.

Convenience factors (Independent variables)			Indirect effects through specific mediator M_k								
			Convenience (M1)			Autonomy (M2)			Safety (M3)		
				95% CI			95% CI			95% CI	
Indirect effect of test level (I_k)	Relative to reference level (J_k)	I–J	Est.	$CI_{2.5}$	$CI_{97.5}$	Est.	$CI_{2.5}$	$CI_{97.5}$	Est.	$CI_{2.5}$	$CI_{97.5}$
Access convenience											
Credit card	No Check-In Needed	AC2 vs. AC1‡	−.112*	−0.217	−0.010	−0.019	−0.057	0.016	−.127*	−0.210	−0.048
Provider App	No Check-In Needed	AC3 vs. AC1	−0.049	−0.126	0.028	0.017	−0.017	0.053	−0.017	−0.095	0.060
Provider App	Credit card	AC3 vs. AC2‡	0.064	−0.035	0.165	.035*	0.003	0.074	.110*	0.036	0.187
Assistance convenience											
Staff phone/text support	On-site support	AS2 vs. AS1‡	−.386*	−0.506	−0.274	0.015	−0.019	0.052	−.442*	−0.543	−0.351
Virtual staff support	On-site support	AS3 vs. AS1‡	−.205*	−0.317	−0.096	.034*	0.001	0.073	−.417*	−0.516	−0.328
Virtual staff support	Staff phone/text support	AS3 vs. AS2	.181*	0.076	0.291	0.019	−0.013	0.055	0.025	−0.049	0.099
Transaction convenience											
Self-scanning terminals	Staffed check-out	T2 vs. T1	.318*	0.066	0.576	.265*	0.164	0.388	−.236*	−0.421	−0.060
Self-scanning own device	Staffed check-out	T3 vs. T1	.286*	0.029	0.545	.278*	0.175	0.405	−.291*	−0.478	−0.114
Fully automated check-out	Staffed check-out	T4 vs. T1	.343*	0.063	0.630	.272*	0.165	0.406	−.413*	−0.622	−0.215
Self-scanning own device	Self-scanning terminals	T3 vs. T2	−0.033	−0.190	0.123	0.013	−0.035	0.065	−0.055	−0.164	0.053
Fully automated check-out	Self-scanning terminals	T4 vs. T2‡	0.025	−0.169	0.220	0.008	−0.053	0.072	−.176*	−0.319	−0.040
Fully automated check-out	Self-scanning own device	T4 vs. T3‡	0.058	−0.059	0.177	−0.005	−0.045	0.033	−.121*	−0.211	−0.037
Verification convenience											
Cost after payment	Cost displayed before payment	V2 vs. V1	−0.022	−0.165	0.119	−0.012	−0.059	0.032	−0.081	−0.182	0.017
Cost after leaving store	Cost displayed before payment	V3 vs. V1‡	−.339*	−0.487	−0.199	−.067*	−0.122	−0.024	−.355*	−0.468	−0.251
Cost after payment	Cost after leaving store	V3 vs. V2‡	−.317*	−0.431	−0.210	−.056*	−0.097	−0.022	−.273*	−0.360	−0.195

* 95% CI does not overlap 0.

‡ Unmediated main effect was significant (cf. Table 4).

DISCUSSION

- Are there any reasons you would go to and shop at an autonomous stores?
- In regards to safety do you think self check out is a viable option for stores?
- How would you feel if a autonomous store lost its autonomy? (5below)