Course Project: Exploratory Data Analysis

Description of the Data Set and its attributes

Objective:

The objective of this report is to analyze the data collected on works on public roads and present the results obtained clearly and objectively. The study data reflects works highly oriented to public services located in Montevideo, Uruguay. A clear example of the works may be repairs of services corresponding to the supply of drinking water, electricity, sanitation, and gas, among others. Among the main attributes of the data can be found those described below.

Data set:

- nro_obra, refers to the work number.
- tipo_remocion, refers to the work location, sidewalk, or driveway.
- fecha_inicio, fecha_fin, refers to the execution period of the work.
- ubicacion, refers to the location of the work.
- propietario, refers to the state entity that owns the work.

Retrieving Data & Data Cleaning

Initial plan for data exploration

Import all necessary packages used along with the EDA.

In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from IPython.display import display
```

Load and read the data

In [2]:
```
filepath = "ObrProg.csv"
data = pd.read_csv(filepath)
data.head()
```

Out[2]:

	ID	nro_remocion	nro_obra	nro_permiso	motivo_obra	tipo_obra	tipo_remocion	fecha_inicio
0	373612	1029638	441067	1	REPARACION REDES DE SANEAMIENTO	PERMISO OBRA VIA PUBLICA	ACERA	2019-12-14 00:00:00.0
1	373613	1029646	441070	1	REPARACION REDES DE SANEAMIENTO	PERMISO OBRA VIA PUBLICA	ACERA	2019-12-10 00:00:00.0

	ID	nro_remocion	nro_obra	nro_permiso	motivo_obra	tipo_obra	tipo_remocion	fecha_inicio
2	373614	1029648	441071	1	REPARACION REDES DE SANEAMIENTO	PERMISO OBRA VIA PUBLICA	ACERA	NaN
3	373615	1029650	441072	1	REPARACION REDES DE SANEAMIENTO	PERMISO OBRA VIA PUBLICA	ACERA	NaN
4	373616	1029655	441074	1	REPARACION REDES DE SANEAMIENTO	PERMISO OBRA VIA PUBLICA	ACERA	2019-12-11 00:00:00.0

5 rows × 33 columns

Check the Datatype and Strcuture

In [3]:
```
print(data.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5265 entries, 0 to 5264
Data columns (total 33 columns):
 #   Column                      Non-Null Count  Dtype  
---  ------                      --------------  -----  
 0   ID                          5265 non-null   int64  
 1   nro_remocion                5265 non-null   int64  
 2   nro_obra                    5265 non-null   int64  
 3   nro_permiso                 5265 non-null   int64  
 4   motivo_obra                 5265 non-null   object 
 5   tipo_obra                   5265 non-null   object 
 6   tipo_remocion               5265 non-null   object 
 7   fecha_inicio                1979 non-null   object 
 8   fecha_fin                   2956 non-null   object 
 9   propietario                 5265 non-null   object 
 10  adjudicatario               5265 non-null   object 
 11  ejecutante                  5265 non-null   object 
 12  nro_cont_o_lici             5208 non-null   object 
 13  ubicacion                   5265 non-null   object 
 14  fecha_solicitud             5265 non-null   object 
 15  fecha_autorizacion          5243 non-null   object 
 16  plazo_autorizado            5243 non-null   float64
 17  fecha_recepcion_provisoria  0 non-null      float64
 18  fecha_recepcion_definitiva  0 non-null      float64
 19  inspector                   5265 non-null   object 
 20  cantidad                    1439 non-null   float64
 21  longitud                    4890 non-null   float64
 22  ancho                       4890 non-null   float64
 23  fecha_alta                  5265 non-null   int64  
 24  Fcrea                       5265 non-null   object 
 25  Ucrea                       5265 non-null   object 
 26  Fact                        5265 non-null   object 
 27  Uact                        5265 non-null   object 
 28  diametro                    3788 non-null   float64
 29  tipo_pavimento              4890 non-null   object 
 30  tipo_equipo                 4163 non-null   object 
 31  plazo_total                 5265 non-null   int64  
 32  vigente                     3581 non-null   object 
```

```
dtypes: float64(7), int64(6), object(20)
memory usage: 1.3+ MB
None
```

Notice that 2 columns have 0 non-null values:

- 17 fecha_recepcion_provisoria 0 non-null float64
- 18 fecha_recepcion_definitiva 0 non-null float64

Since they have no values, let's drop those columns.

In [4]:
```
OriginalData = data.copy() # Save the original data set
data.drop(['fecha_recepcion_provisoria','fecha_recepcion_definitiva'],axis=1,inplace=Tr
print(data.columns.tolist())
```

```
['ID', 'nro_remocion', 'nro_obra', 'nro_permiso', 'motivo_obra', 'tipo_obra', 'tipo_remo
cion', 'fecha_inicio', 'fecha_fin', 'propietario', 'adjudicatario', 'ejecutante', 'nro_c
ont_o_lici', 'ubicacion', 'fecha_solicitud', 'fecha_autorizacion', 'plazo_autorizado',
'inspector', 'cantidad', 'longitud', 'ancho', 'fecha_alta', 'Fcrea', 'Ucrea', 'Fact', 'U
act', 'diametro', 'tipo_pavimento', 'tipo_equipo', 'plazo_total', 'vigente']
```

Let's analyze the columns with large missing data.

- 7 fecha_inicio 1979 non-null object
- 8 fecha_fin 2956 non-null object
- 20 cantidad 1439 non-null float64
- 28 diametro 3788 non-null float64
- 32 vigente 3581 non-null object

Since the fecha_inicio and fecha_fin columns has a lot of missing values, we will eliminate them and use fecha_autorizacion and plazo_autorizado instead.

In [5]:
```
data.drop(['fecha_inicio','fecha_fin'],axis=1,inplace=True)
print(data.columns.tolist())
```

```
['ID', 'nro_remocion', 'nro_obra', 'nro_permiso', 'motivo_obra', 'tipo_obra', 'tipo_remo
cion', 'propietario', 'adjudicatario', 'ejecutante', 'nro_cont_o_lici', 'ubicacion', 'fe
cha_solicitud', 'fecha_autorizacion', 'plazo_autorizado', 'inspector', 'cantidad', 'long
itud', 'ancho', 'fecha_alta', 'Fcrea', 'Ucrea', 'Fact', 'Uact', 'diametro', 'tipo_pavime
nto', 'tipo_equipo', 'plazo_total', 'vigente']
```

Let's delete useless data.

In [6]:
```
data.drop(['ID','nro_cont_o_lici','Fcrea','Fact','cantidad','fecha_alta','plazo_total',
print(data.columns.tolist())
```

```
['nro_permiso', 'motivo_obra', 'tipo_obra', 'tipo_remocion', 'propietario', 'adjudicatar
io', 'ejecutante', 'ubicacion', 'fecha_solicitud', 'fecha_autorizacion', 'plazo_autoriza
do', 'longitud', 'ancho', 'Ucrea', 'Uact', 'tipo_pavimento', 'vigente']
```

Given the following proportions of unique values, we categorized the following columns as having only one value. In this way, we will eliminate these columns.

In [7]:
```
print(data.Ucrea.value_counts())
print('Proportion =' , 100*round(data.Ucrea.value_counts()[1]/data.Ucrea.value_counts()
```

```
print(data.Uact.value_counts())
print('Proportion =', 100*round(data.Uact.value_counts()[1]/data.Uact.value_counts()[0]

print(data.vigente.value_counts())
print('Proportion =', 100*round(data.vigente.value_counts()[1]/data.vigente.value_count

print(data.tipo_obra.value_counts())
print('Proportion =' , 100*round(data.tipo_obra.value_counts()[1]/data.Ucrea.value_coun

data.drop(['Ucrea','Uact','vigente','tipo_obra'],axis=1,inplace=True)
data.head()
```

```
USR_UCCRIU    5222
IM2000699       43
Name: Ucrea, dtype: int64
Proportion = 0.8 %
USR_UCCRIU    5222
IM2000699       43
Name: Uact, dtype: int64
Proportion = 0.8 %
N    3417
S     164
Name: vigente, dtype: int64
Proportion = 4.8 %
PERMISO OBRA VIA PUBLICA    4994
INTERVENCION MENOR           271
Name: tipo_obra, dtype: int64
Proportion = 5.2 %
```

Out[7]:

	nro_permiso	motivo_obra	tipo_remocion	propietario	adjudicatario	ejecutante	ubicacion	fe
0	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	BRIG GRAL DIEGO LAMAS DESDE 1534 HASTA 1534 EN...	
1	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	PROF FRANCISCO GAMEZ MARIN DESDE 2413 HASTA 24...	
2	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	AV ISLAS CANARIAS DESDE 4436 HASTA 4436 ENTRE ...	
3	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	SEPEE DESDE 1787 HASTA 1787 ENTRE ALMIRON Y AV...	

	nro_permiso	motivo_obra	tipo_remocion	propietario	adjudicatario	ejecutante	ubicacion	fe
4	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	JUAN J RAISSIGNIER DESDE 2539 HASTA 2539 ENTRE...	

Let's review the Data information again.

In [8]:
```
data.isnull().sum().sort_values()
```

Out[8]:
```
nro_permiso            0
motivo_obra            0
tipo_remocion          0
propietario            0
adjudicatario          0
ejecutante             0
ubicacion              0
fecha_solicitud        0
fecha_autorizacion    22
plazo_autorizado      22
longitud             375
ancho                375
tipo_pavimento       375
dtype: int64
```

Let's correct the Date data to generate a Categorical Feature, also add some extra relevant data.

In [9]:
```
data['fecha_solicitud'] = data['fecha_solicitud'].apply(lambda x: x[:7])
data['fecha_autorizacion'] = data['fecha_solicitud'].apply(lambda x: x[:7])
data['Am2'] = data['longitud']*data['ancho']
data.head()
```

Out[9]:

	nro_permiso	motivo_obra	tipo_remocion	propietario	adjudicatario	ejecutante	ubicacion	fe
0	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	BRIG GRAL DIEGO LAMAS DESDE 1534 HASTA 1534 EN...	
1	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	PROF FRANCISCO GAMEZ MARIN DESDE 2413 HASTA 24...	
2	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	AV ISLAS CANARIAS DESDE 4436 HASTA 4436 ENTRE ...	

	nro_permiso	motivo_obra	tipo_remocion	propietario	adjudicatario	ejecutante	ubicacion	fe
3	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	SEPEE DESDE 1787 HASTA 1787 ENTRE ALMIRON Y AV...	
4	1	REPARACION REDES DE SANEAMIENTO	ACERA	MUNICIPIO DE MONTEVIDEO	GIBEROL S.A.	GIBEROL S.A.	JUAN J RAISSIGNIER DESDE 2539 HASTA 2539 ENTRE...	

Feature Engineering and Variable Transformation

Once we achieve clean data, we can focus on enhancing the features and encoding categorical features.

In [10]:
```
motivo_obra_counts = data['motivo_obra'].value_counts()
other_motivo_obra = list(motivo_obra_counts[motivo_obra_counts <= 100].index)
data['motivo_obra'] = data['motivo_obra'].replace(other_motivo_obra, 'VARIOS')
print(data['motivo_obra'].value_counts().sort_values(ascending=False),'\n')

adjudicatario_counts = data['adjudicatario'].value_counts()
other_adjudicatario = list(adjudicatario_counts[adjudicatario_counts <= 100].index)
data['adjudicatario'] = data['adjudicatario'].replace(other_adjudicatario, 'VARIOS')
print(data['adjudicatario'].value_counts().sort_values(ascending=False),'\n')

ejecutante_counts = data['ejecutante'].value_counts()
other_ejecutante = list(ejecutante_counts[ejecutante_counts <= 100].index)
data['ejecutante'] = data['ejecutante'].replace(other_ejecutante, 'VARIOS')
print(data['ejecutante'].value_counts().sort_values(ascending=False),'\n')

tipo_pavimento_counts = data['tipo_pavimento'].value_counts()
other_tipo_pavimento = list(tipo_pavimento_counts[tipo_pavimento_counts <= 400].index)
data['tipo_pavimento'] = data['tipo_pavimento'].replace(other_tipo_pavimento, 'VARIOS')
print(data['tipo_pavimento'].value_counts().sort_values(ascending=False),'\n')
```

```
REPARACION REDES DE SANEAMIENTO     1543
TENDIDO DE CABLE SUBTERRANEO        1342
CONEXIONES DOMICILIARIAS            1212
TENDIDO DE TUBERIAS                  562
VARIOS                               500
TENDIDO FIBRA OPTICA SUBTERRANEA     106
Name: motivo_obra, dtype: int64

BYCIC LIMITADA                                          865
COMPAÑIA ELECTROTECNICA INDUSTRIAL S R L                780
POSSAMAI CONSTRUCCIONES LTDA.                           619
VARIOS                                                  608
GIBEROL S.A.                                            579
C I E M S A CONSTRUCCIONES E INSTALACIONES ELECTROM     425
ZIKNOR SA                                               370
GOFINAL S.A.                                            350
```

```
TEYMA URUGUAY S A                                          349
STILER  S.A.                                               193
CIETEL S.A.                                                127
Name: adjudicatario, dtype: int64

BYCIC LIMITADA                                             865
COMPAÑIA ELECTROTECNICA INDUSTRIAL S R L                   718
GIBEROL S.A.                                               642
POSSAMAI CONSTRUCCIONES LTDA.                              639
VARIOS                                                     527
C I E M S A CONSTRUCCIONES E INSTALACIONES ELECTROM        426
ZIKNOR SA                                                  386
GOFINAL S.A.                                               350
TEYMA URUGUAY S A                                          349
STILER  S.A.                                               130
CIETEL S.A.                                                127
ELECTROSISTEMAS S.A                                        106
Name: ejecutante, dtype: int64

BALDOSAS          1809
VARIOS            1222
TIERRA/CESPED      893
HORMIGON           521
ASFALTO            445
Name: tipo_pavimento, dtype: int64
```

In [11]:
```
data.loc[:,['plazo_autorizado','longitud','ancho','Am2']].describe().T
```

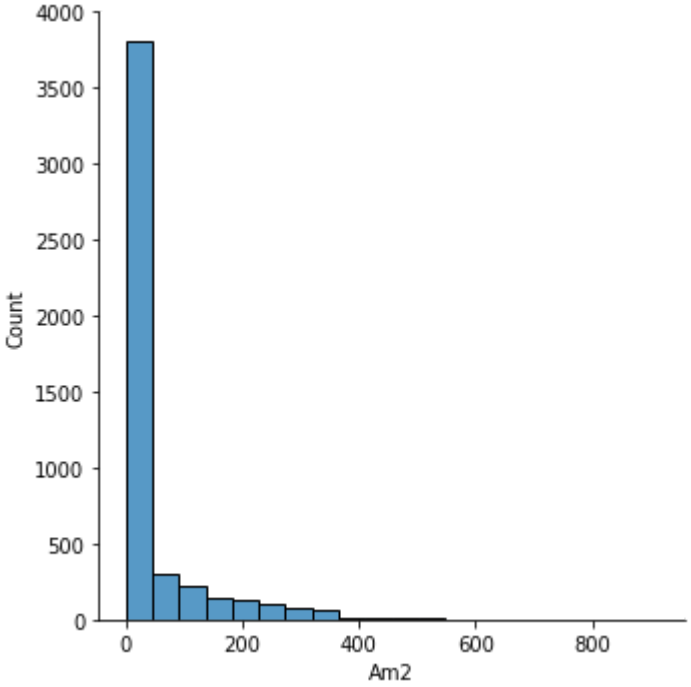
Out[11]:

	count	mean	std	min	25%	50%	75%	max
plazo_autorizado	5243.0	9.523746	6.932082	1.0	5.0	7.00	15.0	90.0
longitud	4890.0	75.597272	126.569751	0.0	4.0	10.00	80.0	500.0
ancho	4890.0	0.810760	0.593473	0.0	0.4	0.80	1.0	12.0
Am2	4890.0	44.435868	84.377945	0.0	3.2	7.58	32.0	912.5

Let's transforn the Data to correct the distortion from the center (skewed data).

In [12]:
```
sns.displot(data['Am2'], bins = 20)
print(data['Am2'].skew())
```

```
2.9751520807924634
```

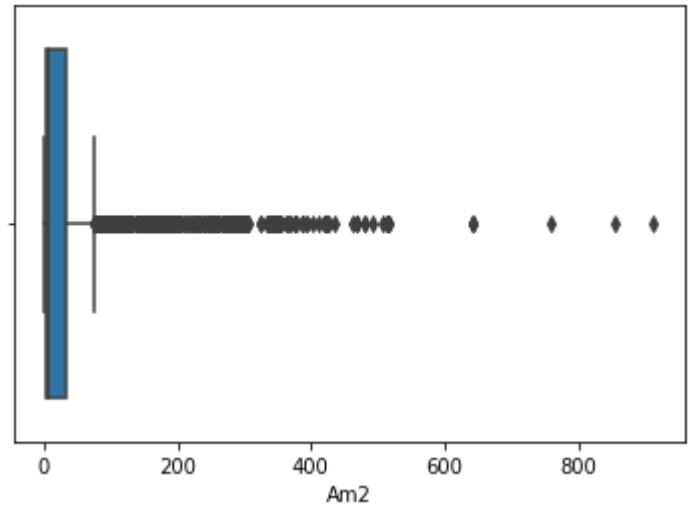


In [13]:
```
q25 = data['Am2'].quantile(q=0.25)
q75 = data['Am2'].quantile(q=0.75)
min = q25 - 1.5*(q75 - q25)
max = q75 + 1.5* (q75 - q25)
mean = round(data['Am2'].mean(),1)
print(min,mean,max)

sns.boxplot(data['Am2'])
```

```
-40.0 44.4 75.2
C:\Users\enzof\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.10_qbz5n2kfra8p0
\LocalCache\local-packages\Python310\site-packages\seaborn\_decorators.py:36: FutureWarn
ing: Pass the following variable as a keyword arg: x. From version 0.12, the only valid
positional argument will be `data`, and passing other arguments without an explicit keyw
ord will result in an error or misinterpretation.
  warnings.warn(
```

Out[13]:
```
<AxesSubplot:xlabel='Am2'>
```

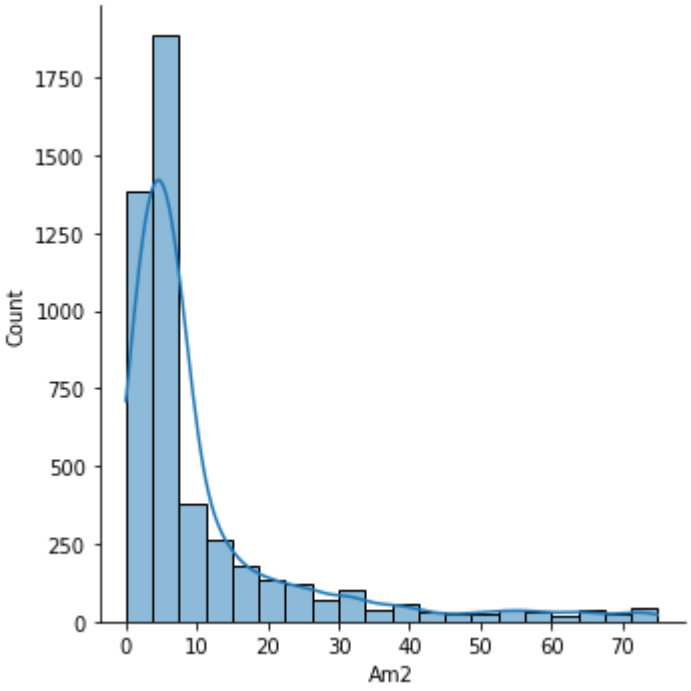


Removing Outliers.

In [14]:
```
list(data['Am2'][data['Am2'] > max].values)
mean = data['Am2'][data['Am2'] < max].mean()

data['Am2'] = data['Am2'].replace(list(data['Am2'][data['Am2'].values > max]), mean-5)
sns.displot(data['Am2'], bins = 20, kde=True)
print(data['Am2'].skew(),mean)
```

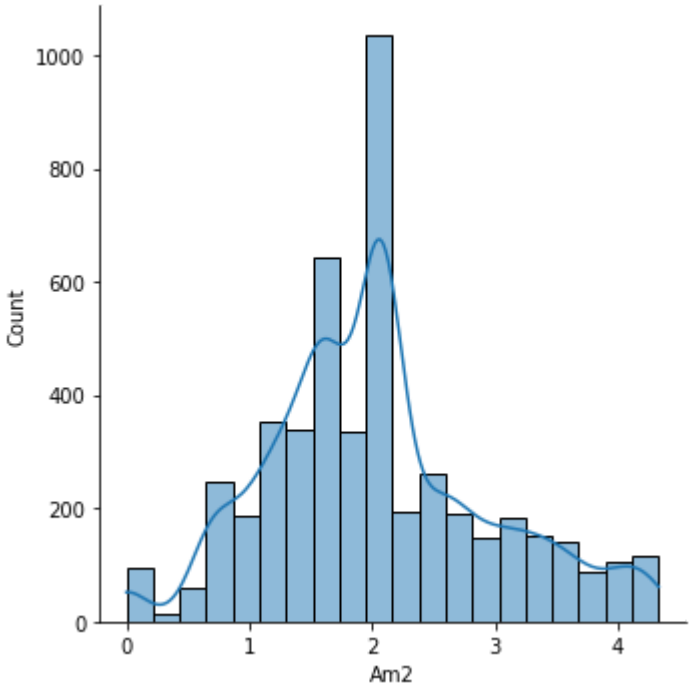
```
2.5155408974780795 11.927786413356362
```



Correcting skewed data with log1p data transformation.

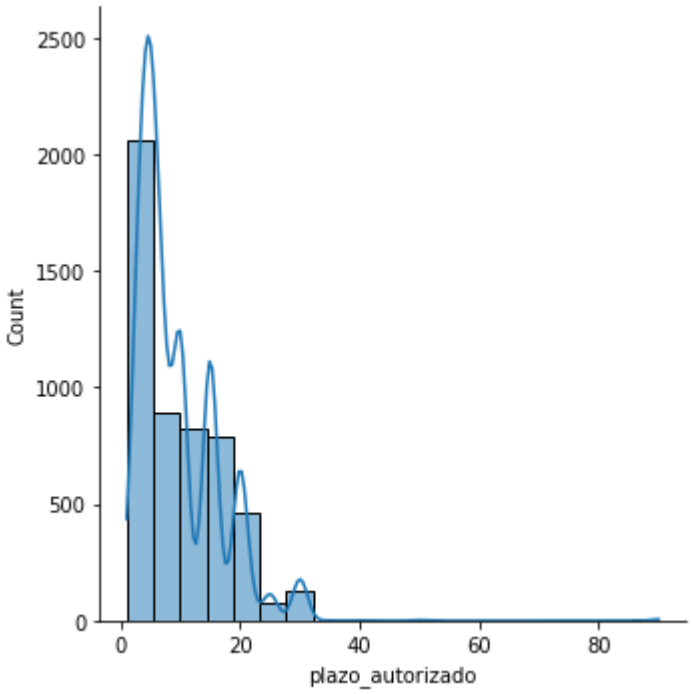
In [15]:
```
data['Am2'] = data['Am2'].apply(np.log1p)
sns.displot(data['Am2'], bins = 20, kde=True)
print(data['Am2'].skew())
```

```
0.4291329392992202
```



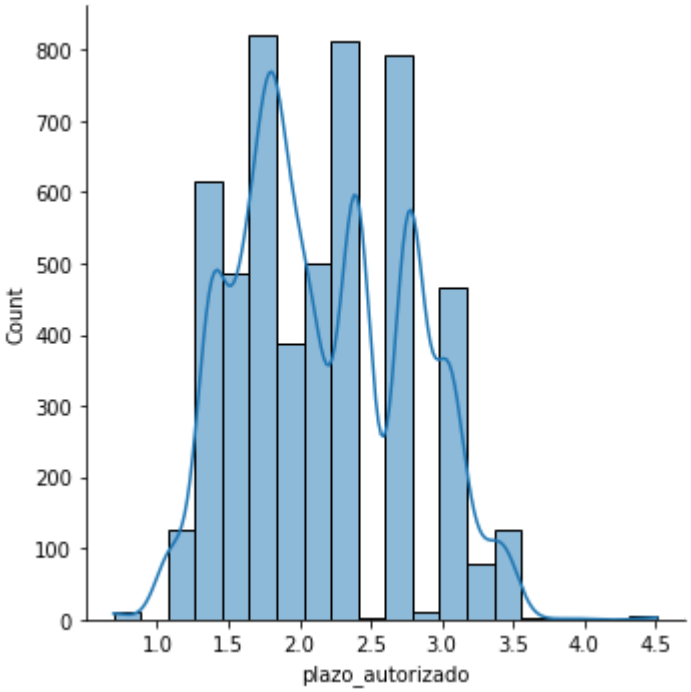
In [16]:
```
sns.displot(data['plazo_autorizado'], bins = 20, kde=True)
print(data['plazo_autorizado'].skew())
```

```
2.2341593115812013
```



In [17]:
```
data['plazo_autorizado'] = data['plazo_autorizado'].apply(np.log1p)
sns.displot(data['plazo_autorizado'], bins = 20, kde=True)
print(data['plazo_autorizado'].skew())
```

```
0.2660176548850139
```



Finally, let's do some One-hot Encoding to some relevant features.

In [18]:
```
df = pd.get_dummies(data, columns = ['motivo_obra','tipo_remocion','propietario','adjud
df.describe().T
```

Out[18]:

	count	mean	std	min	25%	50%	75%
nro_permiso	5265.0	5.692498	12.922283	1.000000	1.000000	1.000000	2.000000
plazo_autorizado	5243.0	2.170802	0.596132	0.693147	1.791759	2.079442	2.772589
longitud	4890.0	75.597272	126.569751	0.000000	4.000000	10.000000	80.000000
ancho	4890.0	0.810760	0.593473	0.000000	0.400000	0.800000	1.000000
Am2	4890.0	2.033535	0.910362	0.000000	1.435085	2.070374	2.555676
motivo_obra_REPARACION REDES DE SANEAMIENTO	5265.0	0.293067	0.455212	0.000000	0.000000	0.000000	1.000000
motivo_obra_TENDIDO DE CABLE SUBTERRANEO	5265.0	0.254891	0.435841	0.000000	0.000000	0.000000	1.000000
motivo_obra_TENDIDO DE TUBERIAS	5265.0	0.106743	0.308815	0.000000	0.000000	0.000000	0.000000
motivo_obra_TENDIDO FIBRA OPTICA SUBTERRANEA	5265.0	0.020133	0.140468	0.000000	0.000000	0.000000	0.000000
motivo_obra_VARIOS	5265.0	0.094967	0.293197	0.000000	0.000000	0.000000	0.000000
tipo_remocion_CORTE ENTERO CIELO ABIERTO	5265.0	0.064198	0.245128	0.000000	0.000000	0.000000	0.000000
tipo_remocion_LONGITUDINAL (OTROS)	5265.0	0.023932	0.152851	0.000000	0.000000	0.000000	0.000000
tipo_remocion_MEDIO CORTE CIELO ABIERTO	5265.0	0.121178	0.326365	0.000000	0.000000	0.000000	0.000000

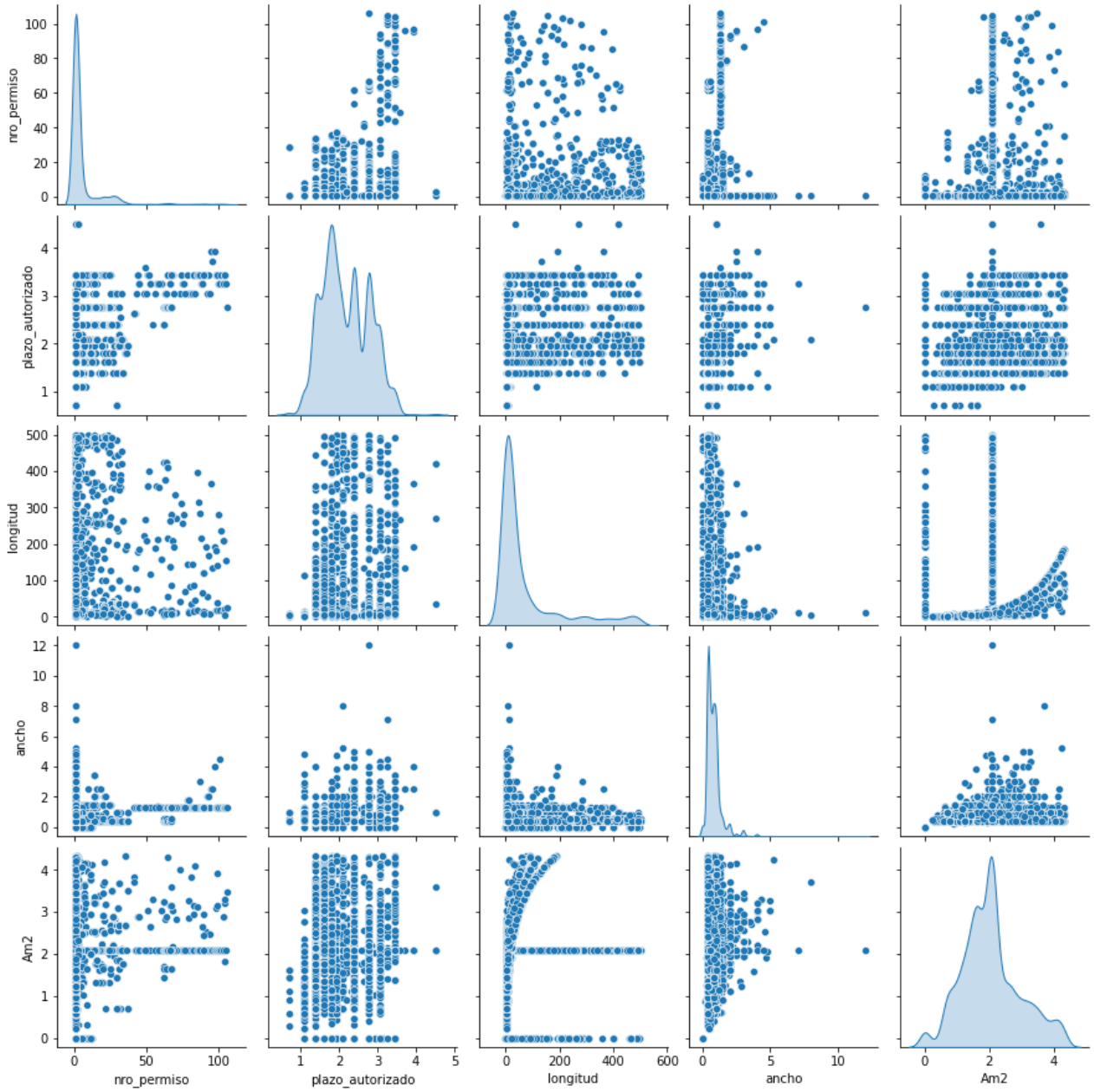
	count	mean	std	min	25%	50%	75%
tipo_remocion_TUNELERA [TRANSVERSAL]	5265.0	0.071225	0.257225	0.000000	0.000000	0.000000	0.000000
propietario_DISTRIBUIDORA DE GAS DE MONTEVIDEO S.A. - GRUPO PETROBRAS	5265.0	0.009877	0.098898	0.000000	0.000000	0.000000	0.000000
propietario_EQUITAL S.A.	5265.0	0.011016	0.104388	0.000000	0.000000	0.000000	0.000000
propietario_M.T.O.P	5265.0	0.010256	0.100763	0.000000	0.000000	0.000000	0.000000
propietario_MUNICIPIO DE MONTEVIDEO	5265.0	0.392783	0.488416	0.000000	0.000000	0.000000	1.000000
propietario_OBRAS SANITARIAS DEL ESTADO	5265.0	0.326116	0.468835	0.000000	0.000000	0.000000	1.000000
propietario_TELEFONICA MOVILES DEL URUGUAY S.A.	5265.0	0.030199	0.171152	0.000000	0.000000	0.000000	0.000000
propietario_U.T.E.	5265.0	0.161823	0.368324	0.000000	0.000000	0.000000	0.000000
adjudicatario_C I E M S A CONSTRUCCIONES E INSTALACIONES ELECTROM	5265.0	0.080722	0.272433	0.000000	0.000000	0.000000	0.000000
adjudicatario_CIETEL S.A.	5265.0	0.024122	0.153441	0.000000	0.000000	0.000000	0.000000
adjudicatario_COMPAÑIA ELECTROTECNICA INDUSTRIAL S R L	5265.0	0.148148	0.355281	0.000000	0.000000	0.000000	0.000000
adjudicatario_GIBEROL S.A.	5265.0	0.109972	0.312884	0.000000	0.000000	0.000000	0.000000
adjudicatario_GOFINAL S.A.	5265.0	0.066477	0.249137	0.000000	0.000000	0.000000	0.000000
adjudicatario_POSSAMAI CONSTRUCCIONES LTDA.	5265.0	0.117569	0.322127	0.000000	0.000000	0.000000	0.000000
adjudicatario_STILER S.A.	5265.0	0.036657	0.187937	0.000000	0.000000	0.000000	0.000000
adjudicatario_TEYMA URUGUAY S A	5265.0	0.066287	0.248806	0.000000	0.000000	0.000000	0.000000
adjudicatario_VARIOS	5265.0	0.115480	0.319630	0.000000	0.000000	0.000000	0.000000
adjudicatario_ZIKNOR SA	5265.0	0.070275	0.255635	0.000000	0.000000	0.000000	0.000000
ejecutante_C I E M S A CONSTRUCCIONES E INSTALACIONES ELECTROM	5265.0	0.080912	0.272725	0.000000	0.000000	0.000000	0.000000
ejecutante_CIETEL S.A.	5265.0	0.024122	0.153441	0.000000	0.000000	0.000000	0.000000
ejecutante_COMPAÑIA ELECTROTECNICA INDUSTRIAL S R L	5265.0	0.136372	0.343216	0.000000	0.000000	0.000000	0.000000
ejecutante_ELECTROSISTEMAS S.A	5265.0	0.020133	0.140468	0.000000	0.000000	0.000000	0.000000
ejecutante_GIBEROL S.A.	5265.0	0.121937	0.327244	0.000000	0.000000	0.000000	0.000000
ejecutante_GOFINAL S.A.	5265.0	0.066477	0.249137	0.000000	0.000000	0.000000	0.000000

	count	mean	std	min	25%	50%	75%
ejecutante_POSSAMAI CONSTRUCCIONES LTDA.	5265.0	0.121368	0.326585	0.000000	0.000000	0.000000	0.000000
ejecutante_STILER S.A.	5265.0	0.024691	0.155198	0.000000	0.000000	0.000000	0.000000
ejecutante_TEYMA URUGUAY S A	5265.0	0.066287	0.248806	0.000000	0.000000	0.000000	0.000000
ejecutante_VARIOS	5265.0	0.100095	0.300155	0.000000	0.000000	0.000000	0.000000
ejecutante_ZIKNOR SA	5265.0	0.073314	0.260677	0.000000	0.000000	0.000000	0.000000
tipo_pavimento_BALDOSAS	5265.0	0.343590	0.474951	0.000000	0.000000	0.000000	1.000000
tipo_pavimento_HORMIGON	5265.0	0.098955	0.298630	0.000000	0.000000	0.000000	0.000000
tipo_pavimento_TIERRA/CESPED	5265.0	0.169611	0.375326	0.000000	0.000000	0.000000	0.000000
tipo_pavimento_VARIOS	5265.0	0.232099	0.422212	0.000000	0.000000	0.000000	0.000000

Looking at the relationship between numerical variables using pair plots and correlation plots

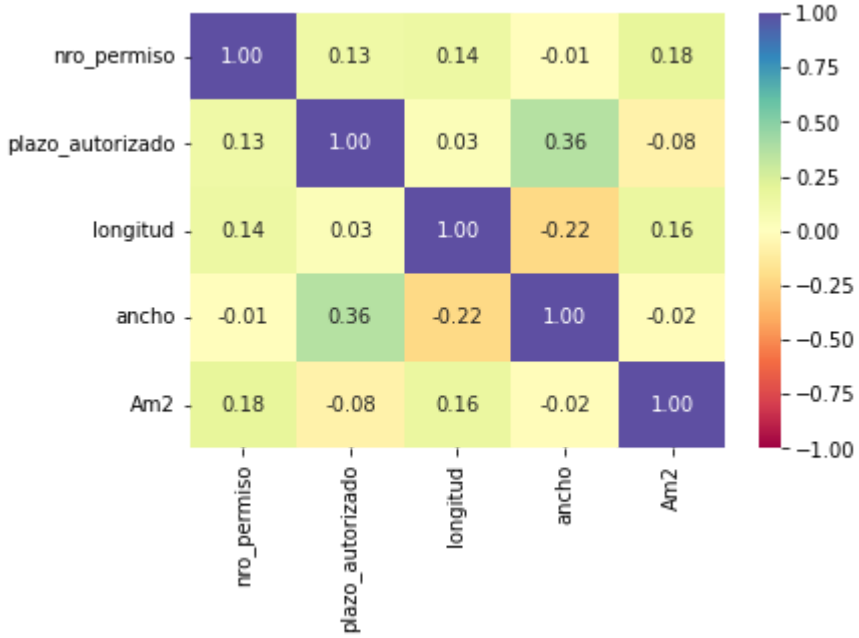
In [19]:
```
sns.pairplot(data, diag_kind="kde")
```

Out[19]:
```
<seaborn.axisgrid.PairGrid at 0x29cb6f1d150>
```



In [20]:
```
correlation = data.corr()
sns.heatmap(correlation, annot=True, vmin=-1, vmax=1, fmt=".2f", cmap="Spectral")
```

Out[20]: <AxesSubplot:>



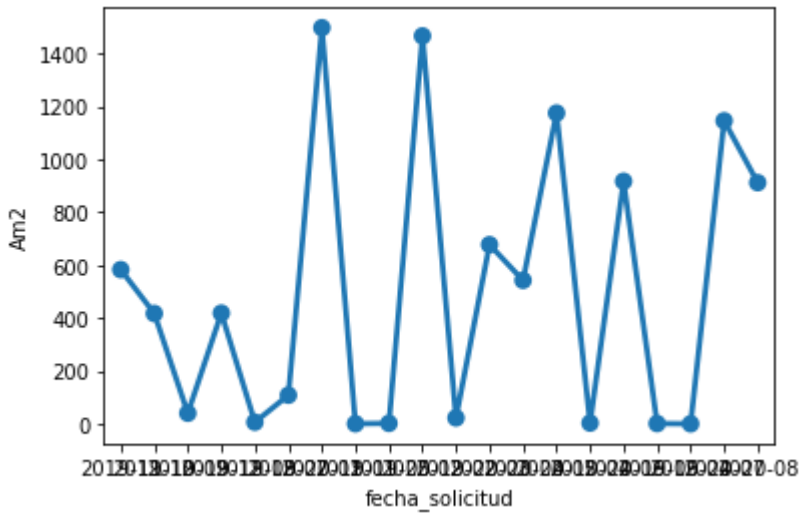
As can be seen in both the pair plot and the heatmap, the analyzed data show a low correlation with each other. In conclusion, the analyzed set is not a good set for the development of the project.

Although the conclusions obtained were not positive, we can express the following observations.

We can see the evolution of square meters of works on public roads throughout the months of the year.

In [21]:
```
sns.pointplot(x='fecha_solicitud', y='Am2', data=data, estimator=sum, ci=None)
```

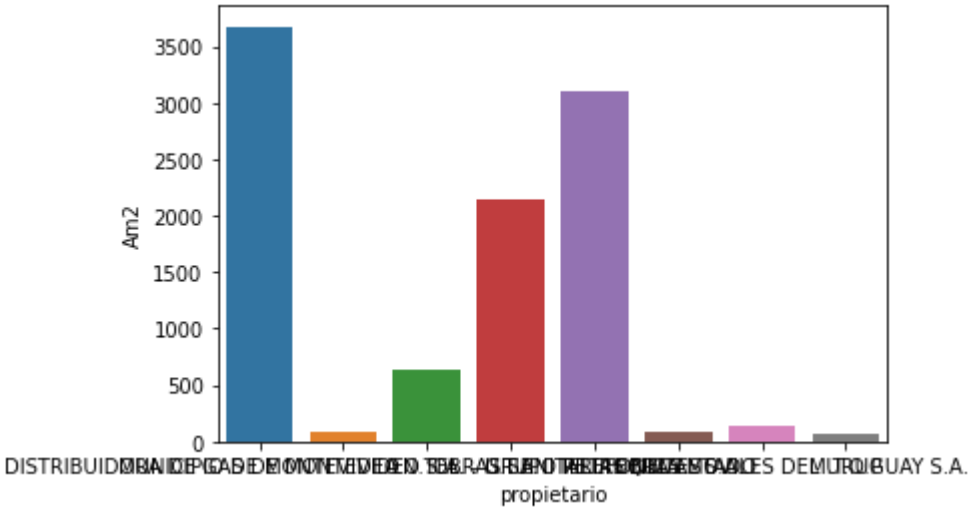
Out[21]:
```
<AxesSubplot:xlabel='fecha_solicitud', ylabel='Am2'>
```



Or we can also see the square meters of work by owner, successful bidder and performer.

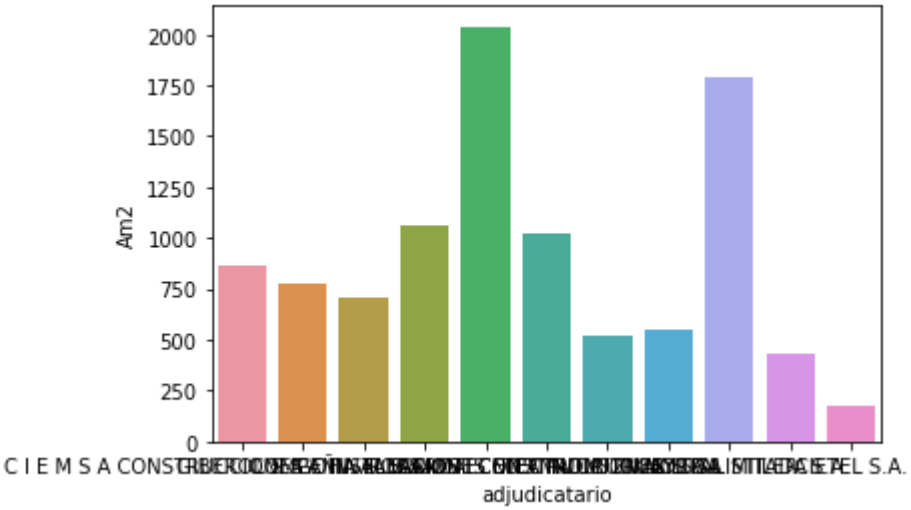
In [22]:
```
sns.barplot(y='Am2', x = 'propietario', data = data, estimator=sum, ci=None)
```

Out[22]:
```
<AxesSubplot:xlabel='propietario', ylabel='Am2'>
```



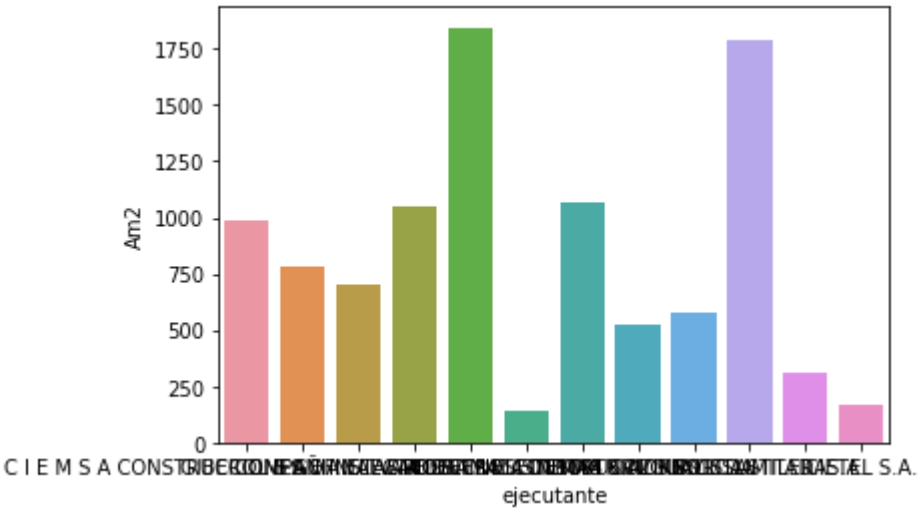
In [23]:
```
sns.barplot(y='Am2', x = 'adjudicatario', data = data, estimator=sum, ci=None)
```

Out[23]: <AxesSubplot:xlabel='adjudicatario', ylabel='Am2'>



In [24]:
```
sns.barplot(y='Am2', x = 'ejecutante', data = data, estimator=sum, ci=None)
```

Out[24]: <AxesSubplot:xlabel='ejecutante', ylabel='Am2'>



Hypothesis Testing

Next we are going to formulate 3 hypotheses about the data set.

H1) Since the owner is the MUNICIPALITY OF MONTEVIDEO, the average square meters of work is 4m2.

H2) Since the owner is the OBRAS SANITARIAS DEL ESTADO, the average authorized term is 15 days.

H3) Since the work is a REPAIR IN THE SANITATION NETWORK, the average square meters of work is 2m.

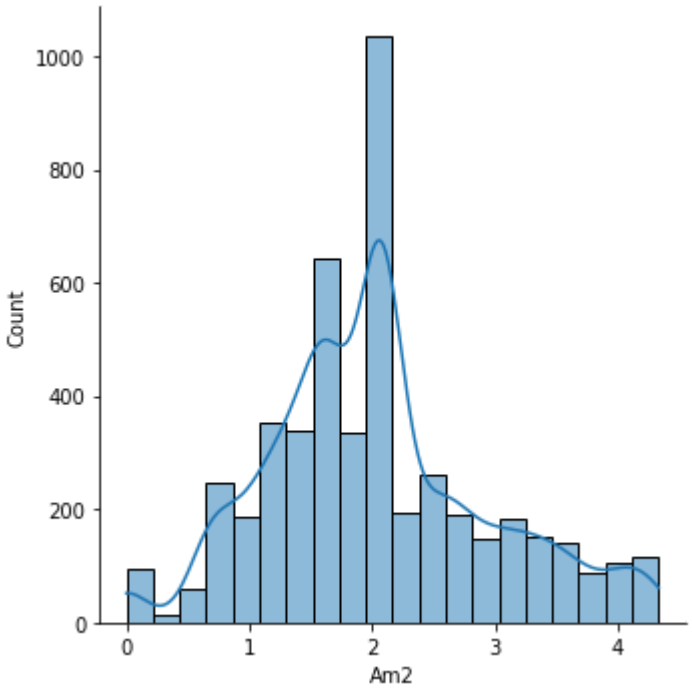
Let's conclude with a formal significance test for the H1 hypotheses and discuss the results.

In [25]:
```
from scipy import stats
from statistics import NormalDist
```

Let's obtain the histodgram of square meters of work for the owner: MUNICIPALITY OF MONTEVIDEO.

In [26]:
```
data['propietario'] = data['propietario'][data['propietario'] == 'MUNICIPIO DE MONTEVID
sns.displot(data['Am2'], bins = 20, kde=True)
```

Out[26]:
```
<seaborn.axisgrid.FacetGrid at 0x29cb728dc00>
```



Let's construct the normal distribution from the data set previously shown.

In [27]:
```
mean = data['Am2'].mean()
std = data['Am2'].std()
print('mean =',round(mean,3),'\n','std =',round(std,3),'\n','skew =', round(data['Am2']

normal = NormalDist(mu=mean, sigma=std).cdf(4)
prob = 1 - normal
```

```
print('prob =',round(prob*100, 1),"% \n",round(normal,3))
```

```
mean = 2.034
 std = 0.91
 skew = 0.429
prob = 1.5 %
 0.985
```

Given the probability of 1.5% that the average square meters of work is 4m2, the proposed hypothesis is rejected and it is stated that the square meters of work are less than 4m2.

Summary

Finally, various hypotheses can be made on the set of data and more relevant information can be collected. In summary, the quality of the initial data is poor, having to carry out extensive data cleaning. On the other hand, it is convenient to request more numerical type data concerning the works executed. This allows us to study in greater depth the intercorrelations between the features.