



US011836659B2

(12) **United States Patent**
Walker et al.

(10) **Patent No.:** **US 11,836,659 B2**

(45) **Date of Patent:** **Dec. 5, 2023**

(54) **METHODS AND SYSTEMS FOR DEPLOYING EQUIPMENT REQUIRED TO MEET DEFINED PRODUCTION TARGETS**

(58) **Field of Classification Search**
CPC G06Q 10/06313; G06Q 10/06315; G06Q 10/0635; G06N 7/01
See application file for complete search history.

(71) Applicant: **Freeport-McMoRan Inc.**, Phoenix, AZ (US)

(56) **References Cited**

(72) Inventors: **Mary Amelia Walker**, Phoenix, AZ (US); **Nicholas Hickson**, Phoenix, AZ (US); **Robert Catron**, Phoenix, AZ (US); **Brian Vaughan**, St. Louis, MO (US); **Hung Jung Lu**, St. Louis, MO (US)

U.S. PATENT DOCUMENTS

5,327,347 A 7/1994 Hagenbuch
7,644,005 B1 1/2010 Billiotte et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102466746 A * 5/2012
CN 107688910 A * 2/2018

OTHER PUBLICATIONS

(73) Assignee: **Freeport McMoRan Inc.**, Phoenix, AZ (US)

Alhasan et al. "Earthwork Haul-Truck Cycle-Time Monitoring—A Case Study" (Mar. 2016) (https://intrans.iastate.edu/app/uploads/2018/03/earthwork_haul-truck_cycle-time_monitoring_case_study_w_cvr-1.pdf) (Year: 2016).*

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

Primary Examiner — Sujay Koneru

(21) Appl. No.: **17/545,276**

(74) Attorney, Agent, or Firm — Fennemore Craig, P.C.

(22) Filed: **Dec. 8, 2021**

(65) **Prior Publication Data**

(57) **ABSTRACT**

US 2022/0101228 A1 Mar. 31, 2022

Related U.S. Application Data

Methods of deploying shovels and haul trucks to meet a defined production target may include: Determining at least one production constraint for a shovel and a material processing system; estimating an effect of entropy on a cycle time of the haul trucks to produce a future cycle time estimate; estimating an effect of entropy on a material processing time of the material processing system to produce a future material processing time estimate; predicting whether a delay will occur during the operation of the shovel, the haul trucks, and the material processing system; estimating a duration of the predicted delay; determining a number of shovels and a number of haul trucks required to meet the defined production target based on the determined production constraint, the future cycle time estimate, the future material processing time estimate, and the duration of

(Continued)

(62) Division of application No. 17/202,655, filed on Mar. 16, 2021, now Pat. No. 11,244,262.

(Continued)

(51) **Int. Cl.**
G06Q 10/0631 (2023.01)
G06Q 10/0635 (2023.01)
G06N 7/01 (2023.01)

(52) **U.S. Cl.**
CPC ... **G06Q 10/06313** (2013.01); **G06Q 10/0635** (2013.01); **G06Q 10/06315** (2013.01); **G06N 7/01** (2023.01)

