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THE INFLUENCE OF TIME AND CROWDFUNDING DONATION ON COVID-19: A GENERALIZED LINEAR MODEL APPROACH

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ABSTRACT

The purpose of this study was to examine the effects that time and community assistance (in the form of donations) had on accrued recoveries from the Novel Coronavirus. This study examined donation transaction data from a community-based national virtual donation platform in conjunction with government released figures on populations and COVID-19 cases in the Philippines. Findings from a Generalized Linear Model showed that at a 0.001 level of significance,

the passage of time affected accrued recoveries by about 14 (13.23) daily, while cumulative individual donations improved recoveries by about 2 (1.69) people. A series of simulations that visualized the effects of time and donations on recoveries evidenced that accrued recoveries were accelerated by donations. Results from the analysis generated a series of recommendations based on Resource-Advantage Theory, along with Disaster Management Theory as applied to supply-chains. The first recommendation was to allow broader access to the platform as an information exchange. An expansion of the crowdsourcing features on the platform was a second recommendation. A third recommendation was establishing a relief distribution network prior to the next disaster.

Keywords: COVID-19, Donations, Disaster Management Theory, Resource-Advantage Theory, Generalized Linear Model.

INTRODUCTION

The Novel Coronavirus (COVID-19) spread aggressively throughout the planet soon after reports of its vigorous transmission were reported in Wuhan, China (Reuters, 2020). In the Philippines, the earliest recorded death outside of China was reported on February 2, 2020 (BBC News, 2020). In a matter of sixteen days, initial reports of casualties from the pathogen were recorded in a country beyond the borders of its origin. By March 16, 2020, the growth of confirmed cases in the Philippines averaged 33.13 percent. Subsequently, the entirety of Luzon Island was placed under lockdown when the average death rate approached 23.77 percent (Guidotti and Ardia, 2020). Deaths related to the pathogen experienced rapid growth throughout March and April 2020. The first doubling of deaths occurred on March 12, 2020. At the end of March, the average daily death rate was 29.27 percent. By April 29, 2020, fatalities from COVID-19 averaged 15.92 percent. Confirmed cases grew on average at a rate of 11.7 percent during the period from March 12 to April 29. An establishment of a national, community-based donation platform occurred when cumulative deaths (from March 12 to March 31) outnumbered recoveries by 1.62 to 1, respectively. On April 14, 2020, thirty days since the lockdown was implemented, cumulative fatalities were 3,472, while aggregated recoveries were 2,069 (Guidotti and Ardia, 2020). Within days of the Luzon Island lockdown, other regions in the Philippines soon imposed similar draconian measures to contain

the pathogenic spread. These lockdowns, which became known as Enhanced Community Quarantines (ECQs) (Gregorio, 2020), had the effect of seizing logistics operations throughout the country (Rita, 2020). Hence, hospital supply-chains were substantially debilitated when the ECQs were applied (CNN Philippines Staff, 2020). Sarkis et al. (2020) forwarded that responses to the pandemic required that infrastructures were available for monitoring, dissemination and predictions of supplies. Supply-chain shortages resulted from inefficiencies and upsets (Sarkis et al., 2020). The presence of remiss and interrupted systems throughout the country were evident in resultant supply shortages reported by media outlets.

As a response to the public health crisis that unfolded before the nation, a diversified industrial corporation undertook, as its Corporate Social Responsibility, the development and establishment of a community-based national virtual donation platform (Gomez, 2020; and Tayao-Juego, 2020). The platform connected hospitals with donors throughout the nation. Hospitals that needed various medical supplies to combat the pandemic placed requests on the website, where donors pledged quantities to match some amount of the solicitations. Effectively, the platform served as a crowdsourced information exchange whereby, the community could coordinate with other individuals and organizations in response to a crisis (Tierney, 2014).

The purpose of this paper was to offer discussion as to the influence of donations and time on accrued recoveries from COVID-19. Charitable giving (donation) in the extant literature on disaster management supply-chains for developing countries received little address as to its effects on affected communities. Consensus in extant literature suggested that relief efforts reduced pain and suffering in a community affected by the disaster. In light of the aggressive pathogenic spread, the crippled hospital supply-chains that resulted from ECQs, and the establishment a community-based national donation platform, this paper sought to examine the magnitude of influence time and donations on the platform had on cumulative recoveries for cities that were served. These were done to ascertain the effectiveness of transactions between donors and beneficiaries to improve the platform further.

Subsequent sections in this paper present literature on Resource-Advantage Theory (R-A Theory), crisis and disaster management, along with findings from the analyses of the community-based national

donation platform. The following section will offer a discussion on R-A Theory and humanitarian logistics, as well as extant literature on crisis and disaster management. A third section will discuss the methods utilized in the analysis. The fourth section will present and discuss findings from conducted investigations. A fifth section concludes this paper with recommendations and conclusions.

REVIEW OF RELATED LITERATURE

Donations in Resource-Advantage Theory

Activities of nonprofit endeavours, as Corporate Social Responsibilities, presented a paradox for theories of the firm. Insights from R-A Theory provided explanations as to the purpose of activities by nonprofit organizations. Hunt and Davis (2008) introduced R-A Theory as a principle of competition between firms. The paper revised the concept of firm resources that distinguished the theory from those based on neoclassical economics. These firm resources were viewed as organizational competencies. Adams et al. (2014) examined the influence of employee knowledge and skill-based resources (operant resources) on firm performance and logistic service competency. The paper found that operant resources had a positive and statistically significant relationship with both logistic service competency and firm performance (Adams et al., 2014). A view on firm resources expanded by Topaloglu et al. (2018) provided an explanation as to the activities of nonprofit organizations. Specifically, the expanded definition of firm financial resources in R-A Theory to include grants and donations gave perspective into activities by nonprofit organizations. Further, the purpose of nonprofit organizations in the expanded theory as cost-effective providers of social value justified the actions of these organizations in a competitive space.

Hunt and Davis (2008) discussed the applicability of the R-A Theory to the purchasing function in supply chain analyses. R-A Theory resulted from the Resource Based View. Nine assumptions of R-A Theory forwarded in the paper distinguished it from neoclassical economics. Demand and human assumptions of the theory were that heterogeneity and dynamism characterized demand; information was asymmetric and costly; and self-interest constrained human motivation. Organizational assumptions of R-A Theory were that superior performance, financially, was the organizational objective;

information was costly and imperfect; firm resources were relational, informational, organizational, human, based in law, physical, and financial. This theory assumed resources were imperfectly imitable, and heterogeneous. Management was assumed to be strategic in its activities through strategy recognition, comprehension, creation, selection, and implementation. The last assumption of R-A Theory was that competition induced disequilibrium between competitors as a result of innovation. When applied to purchasing, firm resources were organizational competencies. These competencies could take the form of tangible (as information technology or extranets with suppliers) and intangible resources (as organizational procedures and policies, as well as knowledge and skills of employees). For purchasing, R-A Theory observed implicit and explicit information through the recognition of information as costly and asymmetric. The condition of asset specificity in purchasing was covered in R-A Theory by an assumption of heterogeneous and imperfectly imitable resources.

Topaloglu et al. (2018) discussed applications of R-A Theory to the nonprofit sector. The paper expanded definitions of the nine R-A Theory principles to include aspects of Commercial Nonprofit Organizations (CNPOs). Human and market principles in the nonprofit sector viewed demand as a social need; and consumers as supporters and members that provided donations, grants and volunteers. Human motivation constrained by self-interest co-existed with altruistic motivations. The objective of a nonprofit organization was the delivery of social value cost effectively. Resources of a nonprofit organization in R-A Theory were grants and donations (financial), tax-exemption status (legal), volunteers (human), organizational image and mission (organization), information, and relationships with sponsors in both corporate and government spheres. In light of the research, resources as volunteers and donors could not be seen akin to customers according to prior discourse.

Benefits to Communities from Crowdsourcing and Information Exchanges

From R-A Theory, crowdsourcing and information exchanges were seen as types of firm level resources. A form of human resource, crowdsources offered expertise and skills to solve problems that would not have been available from any one individual or organization. Infrastructures that enabled crowdsourcing in areas affected by a disaster were platforms that provided short messaging services,

along with information communication technologies (Tierney, 2014). An infrastructure that facilitated the flow of information along the healthcare supply-chain was a health information exchange (HIE) network. Walker (2018) discussed benefits that accrued to hospitals in the first three years from participation in health information exchanges. Of the benefits were higher technical efficiency, total factor productivity, reductions in labour resources, as well as improved workflows (Walker, 2018).

Walker (2018) explored if participation in a health information exchange network improved hospital efficiency. A HIE served as a platform for the transfer of information on patients between organizations in the healthcare system. Timely and accurate information was shared from participation in a HIE. This allowed for coordination between healthcare providers for the benefit of patients. A two-stage analysis system utilized the Malmquist algorithm to determine efficiency values. The Malmquist algorithm was discussed as an extension of the Data Envelopment Analysis technique. This algorithm measured efficiency changes over time. DEA models in the paper were input-oriented as management could control the selection of inputs. Then, regression models determined the magnitude of influence various hospital characteristics had on the index values. The study found that hospitals that utilized an HIE network exhibited improved technical efficiency and total factor productivity. Findings from the study showed hospitals that participated in a HIE network were more likely to have greater technical efficiency. Hospitals that participated in an HIE network and utilized electronic hospital records were also more likely to have higher Total Factor Productivity. From the data, hospital total factor productivity benefits were experienced by hospitals for one to three years of participation in an HIE. This was attributed to a reduction in labour resources as work was not repeated between hospitals. Limited gains in total factor productivity was also attributed to hospitals that augmented workflows to better take advantage of the HIE. The paper forwarded that interoperability of the HIE was critical for improved coordination in health services.

Time and Relief Efforts in Humanitarian Logistics and Crisis and Disaster Management

In the aftermath of a disaster, extant literature described how complexities in logistics were compounded by the pressure to respond. Crises confounded long-standing paradigms in supply-chain logistics

that professed cost-savings. Areas affected by disasters did not exist in a state of normal operating conditions (an assumption of many business models), rather the extraordinary measures that had to be taken to supply relief goods and services often resulted in higher costs along the supply-chain (Choi, Rogers, and Vakil, 2020). Parallels with R-A Theory and literature on crisis and disaster management recovery exist. More specifically, resources that enhanced flexibility and resilience were relationships (Bradaschia and Pereria, 2015; Callaghan, 2016; Ponis and Ntalla, 2016; Grube and Storr, 2018; and Morris, 2019), information from outside organizations (Callaghan, 2016; Ageron et al., 2018; Grube and Storr, 2018; Morris, 2019; Rasheed et al., 2019; and Stute et al., 2020), operational policies (Manopiniwes, Nagasawa and Irohara, 2014; Bradaschia and Pereria, 2015; Callaghan, 2016; Ponis and Ntalla, 2016; Ageron et al., 2018; Morris, 2019; Rasheed et al., 2019; and Stute et al., 2020), humans (Callaghan, 2016; Ageron et al., 2018), laws (Tierney, 2014), physical infrastructures (Manopiniwes, Nagasawa and Irohara, 2014; and Stute et al., 2020), and financial (Topaloglu et al., 2018). From Manopiniwes et al. (2014), costs in a humanitarian logistics model were affected most by response times. As response times grew to supply affected communities, the logistics costs inevitably increased (Manopiniwes et al., 2014). Bradaschia and Pereria (2015) examined supply-chain flexibility and how it fortified organizational resilience. The paper forwarded that the existence of previous resources provided operational alternatives that facilitated flexibility (Bradaschia and Pereria, 2015). From Disaster Management Theory, probabilistic innovation advocated crowdsourcing and Collaboration Technologies to generate solutions to disaster-born issues (Callaghan, 2016). Relationship resources, as identified by R-A Theory, facilitated capacity flexibility (Ponis and Ntalla, 2016). Where traditional logistics models forwarded cost-reduction, in humanitarian logistics cost optimization was a more sensible goal (Ageron et al., 2018). Grube and Storr (2018) identified roles entrepreneurs served in the wakes of particular disasters. Related to concepts of crowdsourcing, entrepreneurs supplied necessary resources to affected communities, employed their social capital to counter uncertainties, as well as the continued practice of commercial activities in the affected community (Grube and Storr, 2018). Strategies to counter hospital supply-chain disruptions involved resources that buffered hospitals from failures within the network of suppliers (Morris, 2019). Information exchanges in an area affected by disaster facilitated the provision of necessary

goods and services (Rasheed et al., 2019). This finding supported literature on organizational resilience. Operational principles, system requirements, and support systems were three design principles found to facilitate information exchanges between organizations engaged in disaster relief efforts (Stute et al., 2020). In a discussion of system efficiency, Hazamah, Yu and See (2021) document the experiences of Malaysia as it battled the pandemic in April 2020. From the study, system efficiency in low density states was hampered due to a lack of resources.

Manopiniwes et al. (2014) presented a mixed integer programming model that minimized the cost of relief item delivery in a disaster. Applied to a case study of flooding in Thailand, the paper discussed decisions to open and use particular warehouses in order to service surrounding communities. The paper highlighted models for facility location and inventory focused on pre-disaster stages in relief chain management. At the pre-disaster stage, determination of facilities and their locations was done. Post-disaster stages were addressed by distribution models. At the post-disaster stage, it was imperative that relief goods were immediately distributed. The model considered available units of an item at a warehouse; the proportion of an item that a warehouse could supply to a surrounding community; demand for an item; warehouse capacity; fixed costs; shipping costs; and response times (both at satisfactory and at maximum levels). From numerical experiments, it was found that as response times increased only shipping costs increased. This implied a relief goods distribution system would open more warehouses to lower response times for each demand point (in an affected community). As response times were allowed to increase fewer warehouses were utilized. Hence, when response times were more restrictive, emergency services were expected to perform better in distributions of relief goods, such that pain and suffering of affected residents could be lowered.

Bradaschia and Pereria (2015) discussed the concept and antecedents of flexibility in a supply chain case study of a hospital system in São Paulo, Brazil. The case study examined a hospital system during the 2009 H1N1 pandemic. Five major antecedents of flexibility in the study were abilities for supply chain redesign, resource alteration and creation; resource prioritization; resource availability through redundancy and robustness, and elimination of processes to facilitate faster responses in a disaster. Supply chain redesign involved

changing suppliers that arrived at new and more efficient supply chain member configurations during a crisis. The redesign was possible within already extant resources. Resource alteration and creation entailed that new resources resulted in new functions, which produced more alternatives to address a shock. In turn, resource alteration and creation fortified organizational resilience. Prioritization allowed flexibility when resources could be reallocated to different purposes or activities. Resource availability through redundancy and robustness allowed for flexibility, which strengthened organizational resilience as buffer stocks afforded time to adapt. Elimination of processes to streamline operations in a crisis helped facilitate flexibility. In the paper, an elimination of processes was viewed as removal of policy barriers that resulted in increased availability of resources. Hence, as more resources were available, patients affected by the pandemic could receive treatment.

Callaghan (2016) discussed probabilistic innovation as part of Disaster Management Theory. The study was purposed as a discourse to build theory on problem-solving for disasters and research. Probabilistic innovation postulated that solutions to disasters found resolution through the collective effort of individuals by social media and crowdsourcing resources. Part of the Disaster Management process involved the construction of risks and variance models that relied heavily on data volume and quality. The role of probabilistic innovation in Disaster Management was to maximize current data for analyses. Probabilistic innovation accrued information from a multitude of resources to inform disaster management efforts. This maximization of data leveraged systems for knowledge and information sourcing, crowdsourcing, and community involvement. Manifestations of probabilistic innovation for resource allocation were crowdsourcing platforms that facilitated Disaster Management efforts. Crowdsourcing platforms were viewed as a form of Collaboration Technologies (CT), which structured community interactions and engagements. Results from effective disaster management were rapid solution developments, increased collaborative scale, and real-time responses from research. Hence, crowdsourcing offered a means by which information could be captured from a community, facts could be verified by members of the crowd (or community), and insights could be drawn from the data. Three paradigms of responses delineated how social media and crowdsourced information in a disaster was used. Social media information was used in assessments of disasters

in a real-time context. Crowdsourced information allowed for the formation of responses to a disaster, in terms of sources and allocations of resources to manage a disaster. Further, crowdsourced information was seen as constrained by the scientific structural paradigm which informed assumptions of prior research in the same field.

Ageron et al. (2018) discussed the practice of outsourcing in hospital supply chains. A means of improvement for patient care conditions were offered in logistics. Improved logistics offered hospitals solutions in the organization of care staff and working time. Patient management looked at patients in the chain of care and integrated administrative and medical stages to address issues from wait times to resource misuse. Particular studies in Information Systems for hospitals looked at the flow of physical resources from tracing blood flows, pharmaceutical flows, to waste elimination. Information flows served as a medium of communication between hospitals and partner institutions. This touched on matters that dealt with integrating internal hospital operations with external organizations. The aspect of efficient logistics in hospitals was dependent on the skills and qualifications of members in the chain, from procurement departments, logistics managers to healthcare workers, and so on. Important criteria in healthcare performance measures were inventory management and the management of information technology. In humanitarian supply chain management, support of vulnerable populations required that limited logistics resources were optimized in terms of cost per beneficiary. The location, replenishment, and management of medical supplies affected the time nurses spent on care provided to patients. Purchasing groups optimized logistics chains for hospitals by their levels of skills in project management, procurement training, managing change resistance, along with key success factors as commitment from top management, cooperation, and communication.

Grube and Storr (2018) discussed four aspects by which entrepreneurs in the United States supplied goods and services to catalyze and encourage community recovery after a disaster. A qualitative research design examined the actions of entrepreneurs after Hurricane Katrina; the 2011 Tuscaloosa, Alabama Tornado; and the 2011 Joplin, Missouri Tornado. From interviews with residents and entrepreneurs, the paper identified roles that entrepreneurs fulfilled in community crises. The paper highlighted the collective action problem residents and entrepreneurs faced in the aftermath of a disaster. Based on

the literature on entrepreneurship within communities of hostile or depleted environments, the paper forwarded that entrepreneurs supplied necessary resources to victims of the disaster. Entrepreneurs utilized social capital to overcome uncertainty on matters from cleaning to re-establishment. Another important role of entrepreneurs after a disaster was the simultaneous practice of both commercial activities and goals in their interactions with a community.

Morris (2019) discussed the strategies hospitals utilized in the presence of supply chain disruptions for drugs. Disruptions in drug supply chains were attributed to natural and man-made disasters, shifts in consumer preferences, changes in technologies, as well as the cessation of firm activities. Hospitals achieved resilience in drug supply chains by either the creation of redundancies in resources, or structuring operations that allowed for flexibility. Subjects of the study were drawn from the United Kingdom National Health Service (NHS) trust and acute care hospitals in Ireland, Northern Ireland, Wales, and England. The paper utilized ordinal regression to determine fill rate performances after a disruption occurred, and shortage performances after an impact. Independent variables of the models were hospital bed numbers, level of Supply Chain Disruption Orientation of a hospital, and the severity of a disruption. The paper evidenced that firms with higher levels of Supply Chain Disruption Orientation were more likely to use strategies in buffering and bridging to overcome supply chain shortages. Strategies to buffer supply chain shortages were increased independence from a supplier; more barriers for protection from a disruption; to find alternative suppliers; increased staff redundancies; augmented care policies; and substitute drug procurement. A supply chain disruption was bridged with strategies as the establishment of closer relationships with suppliers, increased control mechanisms on suppliers, more cooperation with suppliers, and improved exchange of information with suppliers. Further, bridging strategies also included participation in risk management with a supplier, development of cross-organizational relationships with close stakeholders, as well as the development of relationships with new stakeholders.

Rasheed et al. (2019) discussed challenges in humanitarian logistics and how the Logistic Support System (LSS) used by the World Health Organization transformed into the Pharmaceutical Information Management System (PIMS). The study explained that disasters in Pakistan, as the October 2005 earthquake, the Sindh and Baluchistan-

Cyclone Yemyin floods in 2007, the Bluchistan earthquake of 2008, and the Internally Displaced People crisis in Swat and Waziristan of 2009 highlighted the limitations of the LSS program. Challenges to humanitarian logistics in crises were identified as unexpected demand, dearth of resources, risks involved with immediate supplies, along with the search for varied resources. Moreover, the availability of products and excessive stock were also brought to light as challenges to the management of supply-chains in disasters. Aspects of humanitarian logistics necessary in relief efforts was the necessity for coordination between organizations, as well as that of information, resources, and services. Changes to the LSS system reconfigured the operational framework from a system dependent on data transfers by disk to a centralized information platform where warehouse sites and geographic locations exchanged supply and demand data. The centralized platform would record user interactions with the site itself and user actions. With this new operational configuration, utilization rates and consumption trends were used to create customized medicine kits for each geographic unit. Further, supplies were better controlled as donation offers were rejected from donors that were unpredictable or unreliable. This was because the PIMS program focused on inventory already in the supply chain, which emphasized reliability. With the Pharmaceutical Information Management System, a form of institutional memory was put in place to help procurement efforts and improve lead times.

Stute et al. (2020) forwarded 14 insights on International Disaster Response (IDR) programs to guide the development and implementation of systems used by Disaster Response Organizations (DRO). As a qualitative study, an inductive approach in the grounded theory discourse generated a new theory on systems design for DROs. From interviews and document analyses, three themes were identified, operational principles, system requirements, and support systems. Within these three themes, a series of insights specific to DRO needs were generated. Within the operational principles, insights were that operations were unique to a disaster; interfaces existed between various stakeholders; teams in a disaster area had to be self-sufficient to reduce burdens on resources locally; local resources must be used as much as possible to achieve missions; Information Technologies must be centralized for IDR activities; information must be regularly synchronized between various actors in the disaster; and certain processes of DROs could be facilitated by Information Communication

Technologies. Insights with regard to system requirements were needed flexibility in systems to address varied conditions; interfaces for actors required simplicity of use; solutions for DROs necessitated scalability to support interactions between organizations, as well as crowdsourcing; and information must be timely, accurate, and stable. The third theme of support systems found that communications needed resiliency in the event of local infrastructure failure; field reports required automation to overcome incomplete information; and utilization of cyber-physical systems to counter risks involved with hostile environments. Furthermore, the paper forwarded that self-organizing networks facilitated resilient communications as such systems leveraged smartphones already used by actors in a disaster field. Another support system was automated reporting, which required less interaction by field agents while data could be used to facilitate communications upward in the organizational hierarchy. Lastly, the utilization of drone technologies would allow for more current information on disaster situations.

With the utilization of a Network Data Envelopment Analysis (NDEA) method applied to Malaysian states, Hazmah, Yu and See (2021) assessed the efficiencies of three stages in managing the pandemic. The NDEA model examined cumulative positive cases, as well as recoveries and deaths as affected by positive cases in critical care, standard wards, and ventilators. Another set of factors examined was shared resources (as frequencies of screening facilities, 3-ply masks, N95 masks, and isolation gowns) between stages in the pandemic management effort. From the study, low-density states received fewer resources than their higher density counterparts. This difference in resources affected the efficiency of low-density states to affect cumulative positive cases, along with recoveries and deaths.

METHODOLOGY

An analysis as to the magnitude of effects that passage of time and donations had on cumulative recovery rates from COVID-19 was conducted by this study. In light of concepts from probabilistic innovation (Callaghan, 2016), the analysis utilized information from a series of sources to inform recommendations that were communicated to the diversified industrial corporation and website maintainer. Independent variables in the model were cumulative individual

donations and the passage of time in days. The dependent variable of the model was the cumulative recoveries from COVID-19 for all cities with hospitals that participated in the donation platform.

In a Generalized Linear Model (GZLM), probability distributions of variables may not follow a normal distribution. This property of a GZLM differs from a Generalized Linear Model (GLM), which assumes components are normally distributed (Urso et al., 2019). A GZLM was used in this study, as variables were not normally distributed due to the number of days in the observation horizon. Another contributing factor to the non-normal distributions of the variables was that the donation platform did not receive donations daily. The probability value (p-value) of an independent variable in this study had to be less than a significance level (α) of 0.05, in order to ascertain that the component had a significant effect on cumulative recoveries. To determine the goodness-of-fit of predictions from the model, this study utilized the R-squared statistic in order to determine the percentage of variation in cumulative COVID-19 recoveries that resulted from the passage of time and cumulative donations.

Donations in this study were viewed from an R-A Theory perspective as resources that facilitated the delivery of social value (Topaloglu et al., 2018). The donation platform collected requests for donations not limited to N95 masks, surgical masks, surgical gowns, vitamin c, head caps, disposable shoe covers, nitrile gloves, personal protective equipment, disposable goggles, and acrylic face shields. Data for donation transactions were drawn from the developer and web maintainer of the crowdsourcing platform. Cumulative donations were the aggregation of individual donations to the platform. The horizon of observation spanned thirty days, from March 31, 2020 to April 29, 2020. An observation horizon of thirty days considered lagged effects anticipated from implementation of the ECQ. Population data for cities were taken from the Philippine Statistics Authority (PSA), based on their respective Philippine Standard Geographic Code (PSGC) (Philippine Statistics Authority, 2020). Recoveries were based on city-level cumulative daily recoveries. Cities included in the study had hospitals that made requests to the platform. Cumulative recoveries were seen as influenced by activities in the community-based donation platform. Effectively, these activities resulted in benefits to society from an R-A Theory perspective (Topaloglu et al.,

2018). Information on recoveries per city was from the Department of Health (DOH) COVID-19 Data Drop (The Republic of the Philippines Department of Health, 2020).

In a state of national crisis, analysis in this study could not benefit from the amenity of time in search for more data. As the death toll mounted and the Philippine health care system brought beyond its serviceable maximum capacity, the corporate data science team pressed for the use of already available information present in the platform datasets and government releases. With each day, figures in the data set evolved as more requests and pledges were transacted. Thus, unlike much of the academic literature, where data sets were static for a particular observation horizon, data sets in this study were in a dynamic state. Available data from the platform was applied and critically examined by nearly daily discussions with members of the corporate data science team and platform volunteers with regard to processes involved in the donation process.

From these discussions with platform volunteers and the corporate data science team, a series of definitions along the process flow were discerned. Arrangements for donation deliveries were agreements made between donors and beneficiaries (hospitals in various cities). Delivery plans manifested as a delivery directly to the hospital by the donor with their own vehicle; the donor and the hospital arrived at a shared delivery cost agreement; or the hospital could pick-up the donations themselves. Only the hospital had the authority to notify the platform that donations were delivered. Such notification by a hospital signalled the completion of the donation and its quantity. One of the logistics difficulties encountered by the platform was donors who wanted to donate to hospitals in cities outside of their own, but lacked the logistic resources to complete such a delivery (community-based national donation platform, personal communication, April 18, 2020).

Data for analyses in this study originated from the platform developer and maintainer, as text form. This information was further curated by the corporate data science team. Information on hospital and donor names, requested items; donated items; and their corresponding quantities were made available for the period from April 3, 2020 to April 29, 2020. Daily data sets held information from the start of the platform to its current day. Only in later data sets were information for cities and timestamps included. From the April 29, 2020 data set, donation information for each hospital was compiled for the observation

horizon. Hospital donation information was further aggregated by city. Donation information was combined with population figures from the PSA and COVID-19 deaths for the Philippines from the DOH.

Curated data sets from the corporate data science team, were wrangled, cleaned, and analyzed by the authors. Data wrangling, cleaning, and analyses were performed in the R Statistics environment, version 3.6.3 (R Core Team, 2020). Growth rate calculations for death and recovery rates were facilitated by the package, “dplyr: A Grammar of Data Manipulation,” version 0.8.5 (Wickham et al., 2020). As much as possible, codes that analyzed platform, as well as population and COVID-19 case data, were written in base R to facilitate reproducibility of results.

Population data for each city came from the Philippine Statistics Authority (PSA) based on their Philippine Standard Geographic Code (PSGC). From the PSGC webpage, population figures at the city and barangay levels came from the 2015 Census. These figures were made available on March 31, 2020 (Philippine Statistics Authority, 2020). Cities and their populations were matched, as much as possible, in accordance with PSGC number designations. Otherwise, cities were identified by triangulation of spelling, hospital address, and discussions with the corporate data science team.

ANALYSIS AND DISCUSSION OF RESULTS

Summary Statistics

As of April 29, 2020, the DOH reported 1,691 different hospitals, nationally, with beds and wards for COVID-19 treatment. Hospitals that reported to the DOH were located in 334 cities (Republic of the Philippines Department of Health, 2020). There were 84 hospitals that made requests for items on the community-based national donation platform. Hospitals that made requests were situated in 46 different cities. Beneficiary hospitals that received donations were situated in 24 cities. At the time analyses were conducted, cumulative recoveries ranged from none (the City of Cabuyao, San Pablo (Laguna), and Talisay) to 175 (Quezon City). On average, cities had cumulative recoveries of about 24 (23.375) people. Cumulative pledges, as number of individual donations, to cities ranged from 1 (Iloilo City

(Capital), Mandaue City, San Pablo (Laguna), and Talisay) to 37 (Quezon City). The number of donations to cities averaged 8 (7.54). Table 1 exhibits the cities that were examined for this study along with cumulative recoveries and donations as of April 29, 2020.

Table 1

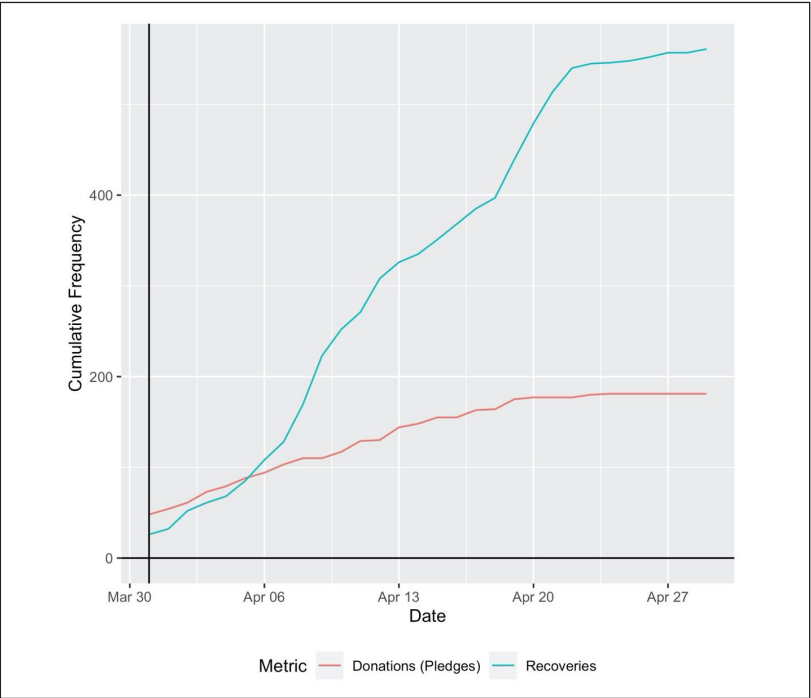
Examined Cities and Cumulative Recoveries, as of April 29, 2020.

Item	City	Cumulative Recoveries	Cumulative Donations
1	BACOLOD CITY (CAPITAL)	3	4
2	BACOR CITY	8	12
3	CITY OF BALANGA (CAPITAL)	1	2
4	CITY OF BIÑAN	4	8
5	CITY OF CABUYAO	0	4
6	CITY OF DASMARIÑAS	3	8
7	CITY OF GENERAL TRIAS	1	11
8	CITY OF MAKATI	78	2
9	CITY OF MANDALUYONG	26	7
10	CITY OF MANILA	87	31
11	CITY OF MUNTINLUPA	15	4
12	CITY OF PARAÑAQUE	43	15
13	CITY OF PASIG	39	14
14	CITY OF SAN JOSE DEL MONTE	3	2
15	CITY OF SAN JUAN	50	4
16	CITY OF SANTA ROSA	6	3
17	CITY OF SANTIAGO	1	2
18	CITY OF VALENZUELA	13	5
19	ILOILO CITY (CAPITAL)	2	1
20	MANDAUE CITY	2	1
21	QUEZON CITY	175	37
22	ROXAS CITY (CAPITAL)	1	2
23	SAN PABLO (LAGUNA)	0	1
24	TALISAY	0	1

Daily aggregations of city-level metrics from March 31, 2020, to April 29, 2020, showed cumulative recoveries and donations trended upwards. Figure 1 exhibits parallel trends between recoveries and donations. Frequencies of recoveries ranged from none (March 28, 2020) to 54 (April 29, 2020), while counts of individual donations spanned from none (April 9, 2020; April 16, 2020; April 22 to 23, 2020; April 25 to 29, 2020), to 14 (April 13, 2020). Cumulatively, by April 29, 2020, there were 561 recoveries and 181 individual donations. On average, about 19 (18.1) people recovered from COVID-19, and about 5 (4.57) donations were made on the platform each day. Table 2 provides summary statistics for aggregated city-level recoveries and pledges.

Figure 1

Cumulative COVID-19 Recoveries and Donations, as of April 29, 2020



Note: Data for Cumulative Recoveries were drawn from (Republic of the Philippines Department of Health, 2020).

Table 2

Summary Statistics for Aggregated Recovery and Donation Frequencies, as of April 29, 2020

Statistic	Recoveries	Recoveries (Cumulative)	Pledges	Donations (Cumulative)
Minimum	0	26	0	48
Maximum	54	561	14	181
Average	18.10	326.10	4.57	136.57

Note: Cumulative Recoveries were drawn from (Republic of the Philippines Department of Health, 2020).

Generalized Linear Model

From the Generalized Linear Model, relationships between the passage of time (days) and the cumulative frequency of individual donations were determined. A GZLM examined 30 days of data, from March 31, 2020, to April 29, 2020. In this model, the influence of days passing and cumulative frequency of individual donations on the number of cumulative recoveries in a cohort city were examined. The model found positive and statistically significant influences of days passing and cumulative donations on the accrued recoveries. For every day that passed, the cumulative number of recoveries in a participant city increased by about 14 (13.23) people (significant at the 0.001 level). For every pledge that was made, cumulative recoveries increased by about 2 (1.69) people (significant at the 0.001 level). Table 3, Results from the GZLM, provides the magnitudes of influence that days and accumulated donations had on cumulative recoveries.

An examination of model deviances allowed for a determination of the goodness-of-fit. The null deviance was 1,064,171 on 29 degrees of freedom, which was based on a model composed of just the intercept. With the inclusion of the independent variables, day and cumulative donations, the model deviance was reduced to 16,974 on 27 degrees of freedom. The resultant correlation between the dependent and independent variables as the R-squared statistic shows was 0.984. Effectively, the independent variables explained 98.4 percent of the variation in the dependent variable.

Table 3

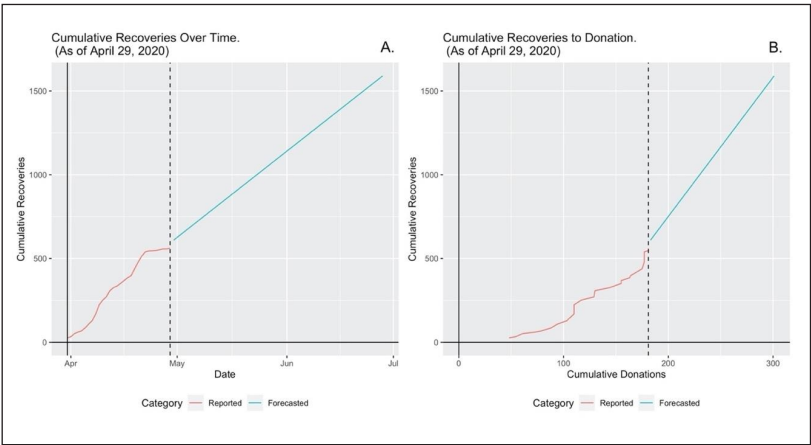
Results from the Generalized Linear Model

Variable	Coefficient	Standard Error	t value	p-value
Intercept	-1300.87	153.67	-8.47	4.450E-09
Day	13.23	1.92	6.88	2.175E-07
Donations (Cumulative)	1.70	0.38	4.45	1.336E-04

A series of simulations that utilized output from the GZLM were conducted to visualize the relationships between the passing of time (in days) and accrued individual donations. Both simulations assumed that each day two more pledges were made on the platform. Figure 2, Cumulative Recoveries to Date and Donations, exhibited that recuperations were expected to increase with the passage of time and more community contributions. A dashed line in Figure 2A was placed at the end of the observation horizon, April 29, 2020. To demarcate the greatest accrued amount of donations made on the platform for the observation period (March 31 to April 29, 2020), a dashed line was placed at 181 donations. The first simulation (Figure 2A) examined the trend in cumulative recoveries in terms of time. As time progressed, cumulative recoveries were expected to increase, as evidenced by the forecast line. Positioned juxtaposed to the first simulation, Figure 2B revealed that with donations, the pace of recoveries would also increase, as evidenced by the slope of the forecasted line. Effectively, the slope of the forecasted line in Figure 2A was shallower than that shown in Figure 2B, which indicated that the rate of recoveries from COVID-19 would be accelerated through community assistance in the form of more donations.

Figure 2

Cumulative Recoveries to Date and Donations



Note: Data for Cumulative Recoveries were drawn from (Republic of the Philippines Department of Health, 2020).

RECOMMENDATIONS AND CONCLUSIONS

In R-A Theory, the objective of nonprofit organizations was to deliver social value cost effectively. Literature in Humanitarian Logistics, as well as Disaster Management Theory, carried an implied consensus that faster responses in the aftermath of a disaster resulted in the relief of pain and suffering of individuals in affected communities. The community-based national donation platform in this study provided hospitals with another source for supplies at a time when their supply-chains were crippled. With the platform, hospitals and community members were provided with a space upon which interaction was catalyzed, and donation transactions could be made. From publicly available information and data from the donation platform, it was found that both cumulative recoveries and accrued donations exhibited an upward trend over time. From an R-A Theory lens, the inflow of donations (a firm resource) to the platform affected the resultant city-level recovery figures (a social value). This underscored the need to have more donations to increase cumulative recoveries from COVID-19 cases in the country. In this case, empirical evidence

was made present in the power of community involvement to battle a pandemic and worldwide crisis.

Considering findings from the study, three recommendations were forwarded to the diversified industrial corporation, along with the developer and maintainer of the platform. A recommendation was to broadly distribute access to the platform in order to accrue more reliable donors. As more individual donations were made to the platform, the recovery rate from people afflicted by COVID-19 stood to increase sharply, as evidenced in simulations shown in Figure 2 (panels A and B). The second recommendation was to expand the crowdsourcing features of the portal. Such would allow the platform to serve as an information exchange (Walker, 2018; Rasheed et al., 2019, and Stute et al., 2020), whereby members in the network could collaborate openly toward relief efforts (Tierney, 2014). The last recommendation to improve the platform was to establish a relief distribution network in order to achieve more donations and lower response times (Manopiniwes et al., 2014). This entailed an establishment of a supplier and benefactor network in conjunction with local government units, and non-governmental organizations (as the Red Cross, the World Health Organization, and hospitals, among others).

In the Philippine context, deaths from COVID-19 began only sixteen days after initial reports of its contagiousness were reported in China. When ECQs (also referred to as lockdowns) were implemented, average daily death rates approached 23.17 percent, while the rate of new cases averaged 33.13 percent. Thirty-days after the applications of ECQs throughout the country, cumulative deaths were greater than cumulative recoveries on the order of 1.67 to 1, respectively (Guidotti and Ardia, 2020). Lockdowns throughout the country debilitated hospital supply-chains at the time when a lethal pathogen spread aggressively between people. From Sarkis et al. (2020), upsets to supply-chains and their inefficiencies caused shortages to emerge at downstream members.

In response to the crippled hospital supply-chains and the state of the crisis faced by the country, a diversified industrial corporation commissioned the development and establishment of a community-based, national virtual donation platform (Gomez, 2020; Tayao-Juego, 2020). From a Disaster Management Theory lens, the platform

was a crowdsource that allowed hospitals to exchange information with members of the community about needed goods to combat the pathogen. Donations made on the platform (a resource in R-A Theory) facilitated the delivery of social value, namely, recoveries from COVID-19. From extant literature, information exchanges benefited members and their supply-chains with improved efficiency, productivity, and workflows, as well as reductions in labor resources (Walker, 2018). A consensus in Crisis and Disaster management literatures was that pain and suffering by individuals in an area affected by disaster were mitigated through coordinated responses and the availability of resources (Manopiniwes et al., 2014; Bradaschia and Pereria, 2015; Callaghan, 2016; Ponis and Ntalla, 2016; Ageron, et al., 2018; Grube and Storr, 2018; Morris, 2019; Rasheed et al., 2019; and Stute et al., 2020).

A GZLM was constructed from donation transactions made on the platform to determine the magnitudes of influence that time, and community assistance had on accrued recoveries. The observation period spanned from March 31, 2020 to April 29, 2020. Due to the paucity of historical information on the Novel Coronavirus and the time pressures presented by reports necessary to track performance on the platform, data was limited to statistical figures released by the government and transactions made on the platform. Data from the platform was combined with information on populations for cities from the Philippine Statistics Authority, and the Department of Health COVID-19 Data Drop shared Google Drive folder. Unlike many supply-chain studies, analysis in this paper did not have the luxury of time or static data sets to work from. Rather, working in conjunction with the corporate data science team and discussions with a platform volunteer, data was censured and processed based on operational knowledge of the platform. Justification for the usage of a GZLM was from the fact that donation data and recovery data were not normally distributed, hence the assumptions that errors were normally distributed could not be supported.

The purpose of this study was to provide evidence and discussion as to the influence community assistance (in the form of donations) had on accrued recoveries from the Novel Coronavirus. Descriptive statistics at the city-level indicated cumulative recoveries ranged from none (the City of Cabuyao, San Pablo (Laguna), and Talisay), to 175 (Quezon City), with an average of 24 (23.375) recoveries per

city. Individual donations on the platform ranged from 1 (Iloilo City (Capital), Mandaue City, San Pablo (Laguna), and Talisay) to 37 (Quezon City), with an average of 8 (7.54) donations per city. Daily aggregations showed that there was an average of 19 (18.1) recoveries per day, while donations averaged 5 (4.57) per day. From the Generalized Linear Model, accrued recoveries increased by about 14 (13.23) people with each day that passed, this magnitude of influence was significant at the 0.001 level. With every individual donation transaction made on the platform, cumulative recoveries increased by 2 (1.69) people. This magnitude was statistically significant at the 0.001 level. The model explained 98.40 percent of the variation in cumulative recoveries.

To better grasp how cumulative recoveries were affected by time and donations, a series of simulations were conducted. The first simulation examined the slope of forecasted recoveries relative to time. A second simulation investigated how forecasted recoveries were affected by donations. When set juxtapose (Figure 2, panels A and B), recoveries from the pathogen were accelerated by community assistance in the form of donations, as evidenced by the steeper forecasted line slope from the second simulation (Figure 2, panel B). In an R-A Theory lens, through the resource of donations, the platform provided social value to members of its information exchange system. Effectively, with the platform in place, recoveries from COVID-19 were accelerated in the cities whose hospitals were members of the exchange.

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