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EDITORIAL PREFACE

This is *Fifth* Issue of Volume *Twelve* of the International Journal of Business Research and Management (IJBRM). The International Journal of Business Research and Management (IJBRM) invite papers with theoretical research/conceptual work or applied research/applications on topics related to research, practice, and teaching in all subject areas of Business, Management, Business research, Marketing, MIS-CIS, HRM, Business studies, Operations Management, Business Accounting, Economics, E-Business/E-Commerce, and related subjects. IJBRM is intended to be an outlet for theoretical and empirical research contributions for scholars and practitioners in the business field. Some important topics are business accounting, business model and strategy, e-commerce, collaborative commerce and net-enhancement, management systems and sustainable business and supply chain and demand chain management etc.

The initial efforts helped to shape the editorial policy and to sharpen the focus of the journal. Started with Volume 12, 2021 issues, IJBRM appears with more focused issues relevant to business research and management sciences subjects. Besides normal publications, IJBRM intend to organized special issues on more focused topics. Each special issue will have a designated editor editors – either member of the editorial board or another recognized specialist in the respective field.

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IJBRM editors understand that how much it is important for authors and researchers to have their work published with a minimum delay after submission of their papers. They also strongly believe that the direct communication between the editors and authors are important for the welfare, quality and wellbeing of the Journal and its readers. Therefore, all activities from paper submission to paper publication are controlled through electronic systems that include electronic submission, editorial panel and review system that ensures rapid decision with least delays in the publication processes.

To build its international reputation, we are disseminating the publication information through Google Books, Google Scholar, RePEc, IDEAS, EconPapers, J-Gate, ScientificCommons, Docstoc, Scribd, CiteSeerX and many more. Our International Editors are working on establishing ISI listing and a good impact factor for IJBRM. We would like to remind you that the success of our journal depends directly on the number of quality articles submitted for review. Accordingly, we would like to request your participation by submitting quality manuscripts for review and encouraging your colleagues to submit quality manuscripts for review. One of the great benefits we can provide to our prospective authors is the mentoring nature of our review process. IJBRM provides authors with high quality, helpful reviews that are shaped to assist authors in improving their manuscripts.

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Strategic Learning and Performance of Small and Medium Sized Dairy Processing Firms in Kenya

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Abstract

The dairy sector plays a key role in the economic growth and development of Kenya, yet many firms in the sector, especially the small and medium sized, continue to face performance challenges such as the unregulated informal milk market, accessing markets, high industry barriers and strategic leadership competency deficiencies that fail to create environments of learning among others. Strategic learning is important in the sustainability of firms and though the subject has received attention both in practice and scholarly, its effect on the performance of small and medium sized dairy processing firms remains uncertain. This study sought to determine the effect of strategic learning on the performance of small and medium sized dairy processing firms in Kenya. The study was anchored on the Path-Goal Leadership Theory. Descriptive and explanatory research designs were used. A census survey was conducted and primary data was collected. A semi-structured questionnaire was distributed to 92 respondents consisting of chief executive officer, finance manager, marketing manager and production managers. In total, 84 questionnaires were filled and returned thus a 91.3% response rate was achieved. Descriptive statistics such as mean and standard deviation were used to explain data characteristics, while multiple regression was used to test the effect of the study variables on firm performance. The results showed that strategic learning has a positive significant effect on performance of small and medium sized dairy processing firms in Kenya, therefore it is perceived that firms that practice strategic learning have better performance. The study contributes to the body of knowledge of strategic management by filling contextual, empirical, and conceptual gaps identified earlier in literature and establishing a nexus of strategic learning and performance of small and medium sized dairy processing firms in Kenya. The study recommends that the small and medium sized dairy processing firms in Kenya should ensure that strategic learning is practiced in their firms by creating a learning culture in their firms, encourage innovations and team learning.

Keywords: Strategic Learning, Firm Performance, Small and Medium Sized Dairy Processing Firms.

1. INTRODUCTION

Strategic leaders are the central point for strategic learning for their firms. They develop a culture of inquiry and analysis from firm experiences, (Schoemaker *et al.*, 2013). Strategic leaders

possess competences that enable them to think strategically, connect and synthesize ideas and identify opportunities, (Norzailan *et al.*, 2016). To enhance the performance of their firms, the strategic leaders should have cognition skills such as talent development, influence and persuasion competencies, and motivate followers to adapt. They develop talent that leads to development of future leaders. Strategic learning is a strategic level process that renews firms' strategies and thus enables firms to stay ahead of their competitors. Strategic learning involves creation of commitment by members of the firm to the strategic direction of the firm, (Hughes *et al.*, 2014). According to Lissier and Achua (2015), the strategic leader that creates an environment and culture for strategic learning and mutual exchange between teams, leads their firms to perform better than others. They understand their environment hence identify emerging trends, analyse and predict environmental changes and needs of their customers and respond appropriately. They review a firm's structure and delegate, hence develop learning cultures in their firms (Adair, 2010). The strategic leaders also encourage innovation and creativity, while incorporating moments of reflection so that learners can assess their weaknesses and seek opportunities for improvement, (Adair, 2010; Hughes *et al.*, 2014). Strategic learning occurs where strategic leaders provide learning scenarios through increasing levels of difficulties in the learning experiences. They become mentors by encouraging their proteges reflect on their experience and help them intellectualize their difficulties, (Norzailan *et al.*, 2016). Strategic learning is dependent on the development of knowledge sharing and team learning, developing a learning culture in the firm and using the knowledge to outdo their competitors.

Small and medium sized dairy processing firms need strategic leaders who scan both their internal and external environments, understand the systems that are likely to affect their future operations and thus focus their energies towards achievement of goals while consecutively taking lessons from past experiences to forecast the future. Pietersen (2010) notes that firms ought to examine their actions, re-scan their environments and modify their strategies accordingly. As such, the firms need strategic leaders who can detect and exploit opportunities as they arise and critically evaluate such opportunities based on previously acquired knowledge and experiences. Strategic learning enables firms to analyse, modify their strategies, norms, procedures and objectives, (Schoemaker *et al.*, 2013). Leaders of small and medium sized firms experience challenges in managing the firms to survive external challenges with limited resources, and thus they need to improve their management focus to strategic development by enhanced management of their human resources (Bolden & Terry, 2000). Sharing knowledge throughout the firm, creating a suitable teaming culture and speeding up the learning processes for learning and utilizing the new knowledge faster than competitors enhances performance, (Pietersen, 2010). Strategic learning enables the members of a firm to be accustomed to changes and how to respond to them which helps individuals and teams to not only learn but also translate this knowledge into actions that have positive effects on performance, (Davis & Davis, 2010).

The changing demands in the global dairy industry requires strategic leaders of dairy processing firms to take advantage of their competences in product development and ensure the production structures of their firms are superior to maintain the changing tastes and wants of an empowered consumer and improve their performance, (Deloitte, 2016). According to Ohlan (2016), global trends indicate that India is the world's largest producer of milk. The Indian dairy market was deregularised in 1991 and this led to an influx of private owned dairy processing firms. However, despite this influx, the marketing of milk is largely by the informal milk marketers, which affects the performance of the milk processors, (Deshmukh, 2014). India, estimates that only 15 percent of the milk produced is formally marketed while the remaining 85 percent is sold informally, (Hemme *et al.*, 2003). Similarly, deregulation of the Australian dairy industry led to mergers and acquisitions of dairy processing firms which led to dominance of few large processors and numerous smaller processors, (Doucouliagos & Hone, 2000). De-regularisation of the milk industry in the European Union in 2015 for example, introduced the abolishment of the quota system which protected the small and medium sized dairy processing firms from the large firms and global price, (Borawski *et al.*, 2020).

In Africa, the performance of the dairy processing industry is affected by imports and low milk consumption, especially in Western and Central Africa, (Ndambi *et al.*, 2017). To improve performance of the dairy processors in the Western and Central African region, marketing strategies and policies should be enhanced alongside increasing milk production and reducing milk product imports. Senegal for instance imports 60 percent of its milk consumed, thus creating competition from imports, especially of powdered milk, (Magnani *et al.*, 2015). Kubkomawa (2019) notes that the West African region faces poor dairy processing technologies; therefore, raw milk supersedes processed milk sales, which affects the performance of dairy processors. Similarly, Val *et al.*, (2021), observe that, larger dairy firms in are organized in a better manner than the small ones which helps them to be resilient in times of difficulties such as the global health crisis brought about by Covid-19 pandemic. According to Bingi and Tondel (2015), the Eastern Africa region accounts for the largest milk production with Ethiopia being the largest producer ahead of Kenya and Tanzania.

The dairy industry in Kenya is one of the best industries in Africa, with thirty milk processors with a range of products and contributing four percent Kenya's Gross Domestic Product, (KDB, 2018). The sector in Kenya has metamorphosed from a monopolistic market owned by the Kenya Government through Kenya Co-operative Creameries (KCC). The cooperative system significantly led to the development and growth of KCC which monopolised the market until 1992, when the industry was liberalised, (Wambugu, *et al.*, 2011). This led to an influx of privately-owned dairy processing firms, many being small-scale processors. The sector is vastly dominated by four very large dairy processors, which are, Brookside Dairy, New KCC, Sameer Agriculture & Livestock and Githunguri Dairies that process above 150,000 litres per day, (ROK, 2013). The four dairy processors also have a combined market share of 64%, with Brookside dairy having a bigger chunk at 23%, (Omore & Baker, 2011). The other three large dairy processors that process above 40,000 litres but below the 150,000 litres have a market share of 17%. The medium level dairies processing firms have a market share of 23%, (ROK, 2013). For instance, Food Business Africa, (2020) reports that Brookside dairy that processes 750,000 litres of milk daily, has organically grown from a small dairy in 1993 and acquired other processors such as Delamere Dairy, Ilara Dairy, Buzeki Dairy and Spin Knit Dairy. This dominance and predation have made it difficult for small processors to thrive through the competition to become large companies. Additionally, the predation has led to an increase in processors owning milk sources from farms to factories, acquiring, distributing and get into retail spaces in the major outlets. As such, the industry is increasingly becoming a heavy investment industry, with the smaller players being pushed out of business by the large processors who have access to internal and external sources of funds. This means that the industry is gradually erecting barriers of entry that younger firms will be unable to crack, and more medium processors being bought, (Murage, 2011).

Further, according to Wambugu *et al.*, (2011) dominant milk products produced in Kenya is fresh white liquid milk contributing 70% of the total milk production, which is majorly sold by milk hawkers who are form the unregulated informal milk market. The informal milk market arises from preference for raw milk by consumers due to its favourable prices over processed milk, and marketing inefficiencies in the formal sector, (Kariuki *et al.*, 2015). In addition, there are market challenges such as unstable supply of milk that is affected by cycles of scarcity and abundance, poor quality of milk and high costs of processing milk, (Rademaker *et al.*, 2016; Kiambi *et al.*, 2020). Although the market for processed milk has increased exponentially since the liberalization of the industry, the informal milk marketers in Kenya continue to sell approximately 56% of the 70% of the country's marketed milk, (Alonso *et al.*, 2018). The remaining 14% is sold by registered milk processing firms, out of which 85% is processed by five large processing firms' processing more than 100,000 liters daily, leaving only 15% for the SME dairy processing firms in spite of their numbers, (Kariuki *et al.*, 2015).

The performance of the small and medium sized dairy processing firms in Kenya is also affected by capital constraints, competition from tax free imports and deficiencies in strategic leadership competences, that fail to create environments of learning, (ROK, 2013; Turner & Endres, 2017). According to Bolden and Terry (2000), strategic leaders of small and medium firm tend to

concentrate on external challenges with limited resources, thus fail to focus within the firm from where solutions must be obtained through enhancement of team involvement which would free up the strategic leaders to focus on strategic development, which ultimately affect their performance.

Empirical literature on strategic learning reveal that several studies have been carried out on the subject. However, the studies reviewed have some gaps that the current study intends to fill. For example, some studies have differing research methodologies (Siren, 2014; Gupta & Bose, 2019), contexts, (Siren & Kohtamaki, 2016), and with different conceptualization of strategic learning, (Gupta & Bose, 2019; Namada, 2013; Li *et al.*, 2014). Therefore, despite the extensive theoretical and empirical attention strategic learning has received, its effect on SME performance in the dairy sector remains uncertain, thus necessitating this study. This study seeks to fill this gap by answering the question; what is the effect of strategic learning on the performance of small and medium sized dairy processing firms in Kenya?

The findings of the study contribute to body of knowledge on strategic learning by suggesting strategic learning factors that contribute to firm performance. The findings also suggest additional areas to be developed as theory related to Goal-Path Leadership theory, and specifically in relation to strategic learning. Finally, the study findings offer a number of recommendations for practice and policy in the enhancement of strategic learning application, assessment and development.

2. LITERATURE REVIEW

2.1 Theoretical Review

The study is anchored on Path-Goal Leadership Theory. The Path-Goal theory of leadership advanced by House (1971), and improved further by House and Mitchell, (1975) contends that following a specific path or behaviour will lead to a particular result, therefore a leader determines the path that employees follow towards achievement of goals leading to superior firm performance, (Antonakis & House, 2013). The Path-Goal theory is behavioural in nature; meaning it seeks to find leadership behaviours that suit both the subordinates and work environment by enhancing the worker's commitment to efficiency and productivity in the firm, (Northhouse, 2015). The theory endeavours to link task and behaviour of the leader with the commitment and performance of the firm. The theory identifies the effectiveness of different behaviours of leaders in different conditions. An effective leader's positive motivation to employees increases their capability for superior performance through clarification of the expected behaviours for attainment of firm goals, (Ivancevich *et al.*, 2002; Kreitner & Kinicki, 2009). House (1996), postulates that for leaders to be effective, their behaviours complement their employee's surroundings and capabilities in ways which compensate for deficits which are key to employee motivation towards their work and firm performance. As noted by Famakin and Abisuga (2016), flexible leadership behaviours enhance employee commitment, whose actions are critical drivers for ensuring the attainment of firm objectives. Unlike other leadership approaches, the path-goal theory strong point is that it specifies four distinct leadership behaviours: directive, participative, supportive and achievement-oriented leadership; which link employee and environment depending on the situation therefore enhancing firm efficiency.

The theory produces greater employee satisfaction and greater performance because of the clarification of paths for them to achieve goals and removes obscurity, (McShane & Glinow, 2015). The theory is helpful to strategic leaders to learn and envision the way their leadership behaviours could encourage commitment of employees and enhance effectiveness and firm performance, set goals, determine the path of attaining the goals and provide guidance in case of difficulties in goal accomplishment, (Cote, 2017). Further, the Path-Goal theory identifies the relevance of a leader in offering cognitive guidance motivation and encouragement to subordinates thus influencing their performance. In addition, the theory guides strategic leaders on the modes of communicating strategic decisions for implementation and which leadership behaviours will enhance their uptake. Farhan (2017), posits that learning leaders tend to inspire

strategic learning in their firms and also understand their subordinates' motivations to learn, hence they adopt appropriate leadership behaviours which influence the subordinates to learn, consequently creating a firm wide learning culture.

On the flip side, Malik *et al.*, (2014) points out that the path-goal theory has weaknesses are due to the complexity of incorporating different aspects of leadership which leads to confusion in interpreting it. Further, the theory has only obtained partial backing from the numerous empirical studies carried out to test its validity, especially in support of all the four dimensions of leadership behaviour in totality. Additionally, the different behaviours exhibited by the leaders do not necessarily increase workers performance, since other factors such as task characteristics, firm culture such as formal lines of authority, benefits and financial incentives influence performance.

Despite the weaknesses, this study found the applicability of the theory relevant to support strategic learning which is the independent variable and firm performance which is the dependent variable. This is because the theory identifies the relevance of a leader in offering cognitive guidance motivation and encouragement to subordinates thus influencing their performance. The theory also acknowledges the existence of several types of leadership behaviours which are applicable at certain circumstances in the firm and partly explain why organisations experience different levels of performance. Finally, the theory appreciates that subordinates have a significant role to play in directing firm performance, hence play a part in the creation of firm culture and also participate in dyadic learning between themselves and their leaders, enhancing firm performance through strategic learning, (Kreitner & Kinicki, 2009).

2.2 Hypotheses Development

Various authors have discussed strategic learning in relation to the performance of a firm. Li *et al.*, (2014) investigated how entrepreneurs in new ventures, from a social capital perspective, use managerial ties with other firms and the government to seize opportunities. The study also explored the moderating role of organizational learning. The study found that managerial ties between firms and the government have a strong positive effect on the opportunities captured. The study further noted that managerial ties and opportunity capture is moderated by organisational learning. The study used organisation learning as a moderator while in the current study strategic learning will be a predictor variable. Additionally, the research was carried out among new ventures only but this current study shall be carried out in existent SME dairy processing firms.

Siren (2014) carried out a study to establish the role of strategic learning in firm success and how it influences competitive advantage. The sample frame comprised of SME software firms in Finland. Primary data was gathered from the firm's managing directors through emailed surveys and secondary data was gathered from articles of the companies that were in operation in 2009 when the software industry in Finland experienced volatilities. The study found that the firms that control strategic learning capabilities result in better performance. The study has some gaps in that the response rate on the primary data was 18% which creates a non-response bias which would cause skewed outcomes and analyses.

In a study to analyse the benefits of an interaction of the processes of strategic planning and strategic learning; and if strategic learning positively moderates firm performance and strategic planning, Siren and Kohtamaki (2016), found that strategic planning and firm performance is moderated positively by strategic learning, but the moderation effect is not linear. However, the study used strategic learning as a moderator therefore presents a conceptualisation gap. The current study uses strategic learning as an independent variable. Similarly, Namada (2013), sought to find out determinants of firm performance of Export Processing Zone firms in Kenya based on systems of strategic planning, organisational learning and strategy implementation. The study used organisation learning a mediating variable and found that organisational learning influences firm performance. The conclusions of the research are applicable to the current study; however, this study presents a methodological gap because it used organisational learning as a

mediating variable but is it is the independent variable in the current study, and was carried out in a different industry thus presenting a contextual gap.

Gupta and Bose (2019), carried out a study with the aim of examining processes of strategic learning for discovery driven transformation. The study aimed to gather opinions on strategic learning processes on capabilities and business models aimed at digital transformations of the firms. The study used a case study and qualitative data was collected through interviewing method. Findings of the study were that an interaction between strategic learning and the operational environment exists. The study is however based on a case study thus cannot be generalized therefore poses a methodological gap. Additionally, the context of the study was in a crowd funding industry in India, therefore cannot be generalized to other industries and countries thus presenting a contextual gap. Also, the interviewing data collection method can introduce interviewer bias.

The literature reviewed revealed that literature on strategic learning both globally and in the local context was limited. Most studies conducted on organisation learning and not strategic learning. The study also found that previous studies had considered organisation learning as either moderating variable (Li *et al.*, 2014), mediating variable, (Gupta & Bose, 2019), or regressed variable (Siren & Kohtamaki, 2016). The study further establishes that most of the studies conducted have other industries and few on SMEs. For these reasons this study identifies that a gap exists in both theoretical and empirical literature. The study sought to fill these gaps by seeking to find out the effect of strategic learning on performance of small and medium sized dairy processing firms in Kenya.

Grounded on the preceding theoretical and empirical literature review, the study developed the conceptual framework as illustrated in Figure 1, which shows the interaction between strategic learning and firm performance.

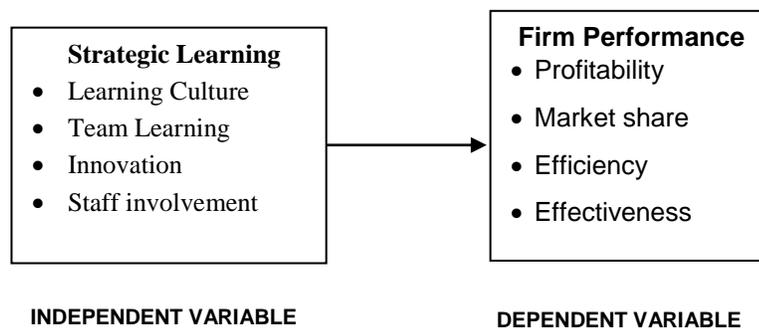


FIGURE 1: Conceptual Framework.

Figure 1 shows the conceptual framework developed from reviewed literature. Strategic learning is the independent variable measured by learning culture, team learning, innovation and staff involvement, while firm performance, measured through profitability, market share, efficiency, and effectiveness.

This study therefore pursues to establish the effect of strategic learning on the performance of small and medium sized dairy processing firms in Kenya. The research hypothesis that guided this study was:

H₁: Strategic learning has no significant effect on performance of small and medium sized dairy processing firms in Kenya.

3. RESEARCH METHODOLOGY

The study used both cross-sectional survey and explanatory research designs, (Saunders *et al.*, 2009). Cross-sectional survey design is used for descriptive research and allows the collection of large amounts of data economically from a sizeable population through questionnaires at a time. Additionally, according to Kothari (2004), cross-sectional survey is concerned with hypothesis construction and testing and can be used in a census survey, which is used in the current study. Explanatory research design is used in assessing the effect of precise changes on prevailing processes and focuses on analysis of a situation or problem to explain relationship patterns between variables, (Sekaran & Bougie, 2010). It is used in the assessment of the consequence of certain variations of a norm or process while focusing on the analyses of a situation or problems to illustrate the linkages in variables and establishes causal relationships between variables, (Saunders, 2011). Based on these reasons, the explanatory research design was found suitable in identifying the degree and feature of cause-and-effect relationship present between strategic learning and performance of small and medium sized dairy processing firms in Kenya.

This study used primary data, collected by use of self-administered semi-structured questionnaires. The questionnaire had closed and open-ended questions. The closed questions were used since they let respondents respond from few stated options. The closed questions were of a five-point Likert scale format. To encourage respondents to give deeper responses, open-ended questions were used to get any information not highlighted in the closed questions. Open-ended or unstructured questions permit respondents to give thoughtful responses, (Saunders, 2011).

Pilot test data from the sample of 10 employees in selected dairy processing firms was used in testing reliability of the questionnaire. The purpose of the pilot test was to establish face and content validity of the questionnaire in conjunction with the opinions sought from professionals and experts in the field of investigation. Component Factor Analysis (CFA) was used to test how well the variables of strategic learning represent the number of constructs. It was found that the Item content Validity Index for strategic learning was 0.957. According to Polit and Beck (2006), a content validity index of above 0.80 is considered acceptable and a content validity index equal 1.00 is considered excellent. Overall, the content validity index for the variables was 0.957 which is greater than the threshold of 0.80 indicating that the research instrument was valid.

To ensure the questionnaire measured what it was intended to measure, a test of reliability was done. The reliability of the questionnaire was measured using Cronbach Alpha with alpha values ranging from zero and one; where a coefficient of greater than 0.7 was accepted as reliable. The results were as shown in Table 1.

TABLE 1: Reliability Coefficients.

Variable	Cronbach's Alpha	
	Cronbach Alpha Coefficients	Remarks
Strategic Learning	0.769	Reliable
Firm Performance	0.934	Reliable
Overall	0.820	Reliable

From these results in Table 1, all the variables had a Cronbach's alpha coefficient greater than 0.7. According to Mugenda (2008), a coefficient of 0.7 is a suitable threshold indicating acceptable reliability. Therefore, basing on these recommendations, the research instrument was found to be reliable.

The targeted population was all the 23 small and medium sized dairy processing firms in Kenya as registered by the Kenya Dairy Board of Kenya as of December 31, 2018. A census survey of all the 23 small and medium sized dairy processing firms registered by the Kenya Dairy Board

was used. The respondents were the managers of the SME dairy processing firms. Four functional areas from each of the small and medium sized dairy processing firms were identified consisting of the Chief Executive Officer, finance manager, marketing manager and production manager, who are leaders of their firms and also custodians of their strategic and operational approaches. The total sample size was therefore 92 respondents.

Questionnaires were administered using the drop-and-pick-later method in order to give adequate time for responses. Research assistants booked appointments with respondent's firm's prior to meeting the respondents for questionnaire administration. The research assistants administered the questionnaires to respondents to establish rapport, clarify the reason for the research and make any other clarifications that may have been necessary (Mugenda, 2008). The research assistants were trained on creation of rapport with the respondents and how to convince the respondents to give relevant data and how to seek clarifications where needed.

Analyses of data was done using both descriptive and inferential statistics. All analyses was aided by the Package for the Social Sciences (SPSS). Descriptive statistics was used to summarise the survey data and included means and standard deviations, while inferential statistics involved regression analysis and was used for testing the hypothesis and drawing conclusions. Inferential data analysis was conducted using Pearson correlation coefficient and multiple regression analysis. Multiple regression analysis was done and interpreted through adjusted R^2 values and p-values at $P < 0.05$ significance level, that is, the results were at 95% confidence level, since it is the level generally used in business and social research, (Mugenda & Mugenda, 2003).

4. RESEARCH FINDINGS

4.1 Descriptive Statistics

Descriptive statistics was used to summarise the major characteristics of the study.

The respondents answered several questions to establish the extent to which strategic learning affects the performance their firms. The respondents were required to indicate their opinions on a five-point Likert scale. The scales were as follows: 1 (No extent), 2 (Little extent), 3 (Moderate extent), 4 (large extent) and 5 (Very large extent). Based on their responses, the descriptive statistics were analyzed using means and standard deviations whose results per question are presented in Table 2.

TABLE 2: Descriptive statistics of Strategic Learning and Firm Performance.

	Mean	Standard Deviation
The management of the firm hold consultative meetings with the employees before key decisions or changes are made	4.25	0.726
The firm adopts new technology with ease	4.21	0.713
Employees in the firm have capacity to generate new ideas	4.20	0.617
The firm has a method of mentoring younger staff into their careers	4.10	0.770
It is easy for the firm to adapt to new processes	3.74	0.981
Employees in the firm are able understand new ideas and concepts and processes	3.71	0.989
Employees in the firm are able to transform information and ideas into new product, processes and systems	3.50	0.977
The firm conducts trainings aligned to firm goals on employees	3.48	0.857
The management encourage learning of new strategies and processes in the firm.	3.39	0.908
The firms hierarchical structure hinders employee involvement in decision making	3.14	0.932
In the firm, employee's initiative and ingenuity is encouraged	2.92	0.943

In the firm, active participation in the management process is encouraged at all staff levels	2.82	0.984
In the firm, delegation of duties by management to subordinates is common	2.61	0.906
The firm's progress is based on team learning	2.15	.938
Aggregate mean score and standard deviation	3.44	0.874

The results in Table 2 indicate that the respondents agreed to a large extent that the management of the SME dairy processing firms hold consultative meetings with the employees before key decisions or changes are made, that the dairy firms adopt new technology with ease and employees in the firms have capacity to generate new ideas. The respondents also agree to a large extent that the SME dairy processing firms have a method of mentoring younger staff into their careers, it is easy for the firm to adapt to new processes, employees are able understand new ideas, concepts and processes as well as employees in the firm are able to transform information and ideas into new products, processes and systems. This is as indicated by mean scores of 4.25, 4.21, 4.20, 4.10, 3.74, 3.71 and 3.50 respectively. The respondents had varied opinions on these aspects as indicated by standard deviations of 0.726, 0.713, 0.617, 0.770, and 0.989. High standard deviations of 0.911 and 0.977 however, indicate that the respondents differed in their opinions concerning the ease of firms in adapting to new processes and firm employees' ability to transform information and ideas into new product, processes and systems.

The study further established that the employees agreed to a moderate extent on the following aspects of strategic learning: firms conduct trainings aligned to firm goals on employees, management encourage learning of new strategies and processes in the firm, hierarchical structure hinder employee involvement in decision making as indicated by mean scores of 3.48, 3.39 and 3.14. Standard deviations of 0.857, 0.908 and 0.932 show varied opinions on these statements. However, the respondents agreed to a little extent that employee initiative and ingenuity is encouraged, active participation in the management process is encouraged at all staff levels, delegation of duties by management to subordinates is common and progress is based on team learning as indicated by means of 2.92, 2.82, 2.61 and 2.15 in that order. Standard deviations of 0.943, 0.984, 0.906 and 0.938 show that the opinions on these statements were varied. The overall mean score was 3.44 and a standard deviation of 0.874. This indicates that responds agreed to a moderate extent that strategic learning is practiced in SME dairy processing firms albeit with varied opinions as indicated by the standard deviation.

4.2 Inferential Statistics

The study sought to determine the effect of strategic Learning on performance of small and medium sized dairy processing firms in Kenya. The corresponding hypothesis stated that strategic Learning has no significant effect on the performance of small and medium sized dairy processing firms in Kenya. To test this hypothesis, multiple regression analysis was done and interpreted through adjusted probability values (p-values) at $P < 0.05$ significance level. A 0.05 significance level is a conventionally accepted threshold to distinguish significant from non-significant outcomes and the smaller the calculated p-value, the more improbable the null hypothesis will be and vice-versa, as advised by Di Leo and Sardanelli (2020). The study used an empirical model to test the statistical significance of the relationship between strategic learning and performance of small and medium sized dairy processing firms in Kenya. Multiple regression model was used to analyze the effect of the independent variables on the dependent variable. Multiple regression models establish the line of best fit and is an accurate model for describing the relationship between the independent and dependent variables, (Field, 2013). The model was found appropriate since the dependent variable is a continuous variable. The direct relationship between strategic learning and firm performance was done using the regression model below:

$$PDPF = \beta_0 + B_1SL + \varepsilon$$

Where: -

PDPF = Performance of small and medium sized dairy processing firms in Kenya
 β_0 = constant
 β_1 = Beta Coefficient
SL = Strategic Learning
 ϵ =Error Term

The results are shown in Table 3.

TABLE 3: Coefficients^a for Multiple Regression.

	B	Standard Error	Beta		
	Model	Unstandardized Coefficients	Standardized Coefficients	T	Sig.
(Constant)	.056	.086		.655	.514
Strategic Learning	.447	.036	.420	12.518	.000

a. Dependent Variable: Performance.

The results in Table 3 show that the adjusted coefficient of multiple determination, $\beta = 0.56$. This means that if all other factors are held constant, the performance of small and medium sized dairy processing firms would be 0.56. The coefficient of strategic learning is 0.447 meaning that if all other factors are held constant and strategic learning is increased by a unit, there would be a 0.447 increase in the performance of small and medium sized dairy processing firms in Kenya. Strategic learning has a p-value of $0.000 < 0.05$ level of significance. Based on the P-value, the study rejects the null hypothesis and concludes that strategic learning has a positive significant effect on performance of small and medium sized dairy processing firms in Kenya.

The findings of this variable are consistent with that of Siren (2014), that firms that control strategic learning capabilities result in better performance of their firms. Further, the findings of Siren and Kohtamaki (2016), that strategic learning is a key ingredient to firm performance. The results are also in agreement with the postulations of the Path-goal theory of leadership by House (1971), which provides that a leader determines the path that employees follow towards the achievement of goals leading to superior firm performance. The theory further postulates that flexible leadership behaviours enhance employee commitment whose actions are critical drivers for ensuring the attainment of firm objectives, (Famakin & Abisuga, 2016; Farhan, 2018). The path-goal theory specifies leadership that links employee and environment depending on the situation therefore contributing to a firm's efficiency.

5. DISCUSSION AND CONCLUSIONS

The study sought to determine the effects of strategic learning on performance of small and medium sized dairy processing firms in Kenya and used both cross-sectional survey and explanatory research designs. Data was collected by use of a semi-structured questionnaire that had both closed and open-ended question. Data was analysed by use of descriptive and inferential analyses. The findings established that strategic learning has a positive significant effect on performance of small and medium sized dairy processing firms in Kenya, thus there is a relationship between strategic learning and performance of SME dairy processing firms in Kenya. The findings of this study are in tandem with postulations by Schoemaker *et al.*, (2013) that strategic learning is essential in shared learning and bolder innovation. Additionally, the findings are in line with findings by Siren (2014), who observed that firms that control strategic learning capabilities result in better performance. Congruently, Siren and Kohtamaki (2016), also observe that strategic learning has a positive effect of firm performance, even if the study looked at strategic learning as a moderator.

Correspondingly, the study recommends that SME dairy processing firms should invest in strategic learning by creating learning culture in their firms by communicating results of goal attainment. Where goals were not met, an examination of the cause should be encouraged and

corrective measures taken. Strategic leaders should also encourage innovation by rewarding and lauding personnel of such innovations, even if set targets were not attained in entirety. Failed team goals should be evaluated and a culture of innovation and learning be embraced in the firms by encouraging learning opportunities from such failures. Considering the SME dairy processing firms in Kenya are often faced with larger barriers on capital and labour markets than larger dairy processing firms, their strategic leaders should encourage staff participation to enable employees develop capacities to generate new ideas, adopt new technology and new processes with ease based on their available resources.

Moreover, to further enhance performance of small and medium sized processing firms, strategic leaders of the firms should hold consultative meetings with employees before making key decisions or changes. It is recommended that the managers of the firms should have methods of mentoring staff into their careers and encourage learning of new strategies and processes in the firm, which can be emphasised by their personnel managers. Further, the strategic leaders ought to continuously engage in personal trainings and other learning avenues to better their leadership skills and overall knowledge in their respective areas of expertise, thereby becoming learning leaders who inspire their subordinates to learn.

The study had some limitations in obtaining sensitive information of their firms, particularly, obtaining financial data on profitability of the small and medium sized dairy processing because the firms are not public listed companies; therefore, financial profit and loss statements are not open to the public. To counteract this limitation, the research formulated the questionnaire to encourage truthful answers through non-threatening questions and also assured the respondents of confidentiality of the information given. The study used a cross sectional design; thus, the findings may not be reliable to make long-term inferences about the performance of small and medium sized dairy processing firms in Kenya. As such longitudinal studies would be important to enable long term observation of the effect of strategic learning in the firms.

Future research should be conducted in the large dairy processing firms in Kenya to establish whether similar results will be obtained. Mediating and moderating variables, such as environmental factors, leader-member relationships and motivation could be used to show the effect on the relationship between strategic learning and firm performance. The study was also grounded in goal-path leadership theory; therefore, alternative theoretical frameworks may be utilized that may contribute differently to the research question and thus contribute further to development of theory and strategic management in general.

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The Role of Communication In COVID-19 Crisis Management: Findings about Information Behavior of German and Italian Young People

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Abstract

Given the different levels of pandemic severity in Germany and Italy, the paper investigates the differences in information behavior, and its consequences, between German and Italian young adults during the COVID-19 pandemic, especially in the first and second waves of infections in the two countries. In particular, the issue of crisis management through institutional communication, the development of information behavior and information consumption throughout the year 2020 are analyzed through a questionnaire-based case study considering the constructs topic fatigue, trust in government sources and vaccination hesitancy. The paper reveals that there are considerable differences in time spent looking for information, with Italian respondents generally spending more time in these activities. Surprisingly, Italian respondents seem to place more trust in their government and institutions than Germans do. Vaccination hesitancy is estimated as higher in Germany than in Italy. People who feel less informed are also less likely to get a vaccination when offered the possibility, moreover, the perception of risk of infection plays a major role in vaccination acceptance. From the point of view of public management, findings of this work highlight the knowledge of citizens' information behavior and habits as relevant to the design of communication campaigns to address health crises.

Keywords: COVID-19, Information Behavior, Trust, Government, Vaccination Hesitancy, Topic Fatigue, Young Adults, Crisis Management, Institutional Communication.

1. INTRODUCTION

By March 2021, countries all over the globe have struggled to contain the COVID-19 pandemic for more than a year. The novel Coronavirus (COVID-19) first emerged in December 2019, and, in the following months, spread globally. By the end of 2020, it had spread to almost every single country on earth and killed close to 2 million people – a number that would keep rising to more than 3.5 million by May 2021, with no end in sight (Dong, Du, & Gardner, 2020).

The pandemic has had a massive effect on the world we live in today. It has changed the way people work (Bick, Blandin, & Mertens, 2020; Kramer & Kramer, 2020), the way people spend their free time (Cellini, Canale, Mioni, & Costa, 2020; Droit-Volet et al., 2020) and the way people interact with each other (Bhat et al., 2020). Not only that, but the pandemic, and the restrictions put in place to fight it, have also caused many challenges to psychological and mental health (Bäuerle et al.,

2020; Khan et al., 2020; Petzold, Plag, & Ströhle, 2020; Thome, Coogan, Fischer, Tucha, & Faltraco, 2020). According to Farooq et al. (2021), the pandemic has amplified the influence of information reporting on human behavior. This is due to people having to react to a new, uncertain health situation by gathering new information that, globally, encouraged people to adopt preventive measures such as self-isolation, avoiding public places, good hygienic care and face mask wearing (K. Wang et al., 2021; World Health Organization, 2021) for long time (Rai, 2020). International organizations, governments, public agencies and local authorities used various media (like mass media, print media and digital & social media) to reach out to the public, mobilize them and convey measures against the extraordinary situation in order to manage the crisis.

Particularly, due to an unprecedented major part of the population working from home (Naidoo, 2020), social media has, for many, become the main source of information during the crisis (Bick et al., 2020; Farooq et al., 2021). The research into this topic implies that the enormous amount of information generated about COVID-19 on social media has overwhelmed users with a strong impact on their lifestyle (Islam, Mahmood, Sadiq, Usman, & Yousaf, 2020).

According to Soroya (Soroya, Farooq, Mahmood, Isoaho, & Zara, 2021), Google Trends reports showed a substantial increase of interest in COVID-19, starting from February 2020. According to an initiative under art direction by Cairo (Schema Design, 2020), however, prior to March 2020, most searches were queries for general information such as “*What is Coronavirus?*”; from the beginning of March, searches evolved towards questions such as “*What are symptoms of Coronavirus?*” and “*How to behave with...*”, among others. In other words, COVID-19 has also changed the way people gather information and process them in order to react to a situation; according to Tang et al. (2021), however, little is known about individuals’ information consumption. This aspect is crucial to guide governments in managing the unprecedented outbreak of a serious disease, to align citizen participation with the proper behaviors to reduce the spread of infection. Particularly, the work of Husnayain et al. (2020) on this topic demonstrated that the volume of online research about COVID-19 correlates significantly with the number of new infections in individual countries (Husnayain, Fuad, & Su, 2020). Thus, there likely exists a correlation between information consumption and level of pandemic severity (as measured in number of COVID-19-related deaths per million inhabitants). Awareness of this relationship may be useful for public management. However, it has not yet been explored by academia.

This paper focuses its research on the target group of young people (under 35 years old) who are less easy to reach via traditional communication channels. Young people, moreover, have been affected especially harshly by the restrictions placed on everyday life (Manivannan, Jogalekar, Kavitha, Maran, & Gangadaran, 2021). Consequently, they have been found to show the most severe cases of pandemic fatigue (Lilleholt, Zettler, Betsch, & Böhm, 2020) – a concept that will be introduced in detail in section 2.3. Therefore, this study will focus on young people, specifically students aged 35 and under, as the subject of our research.

Given the above, this paper aims to answer the following research question:

How does the severity of the ongoing pandemic influence the information behavior of young people, in Germany and Italy, in the perspective of crisis management?

Thereby, the two countries stand for different levels of severity of the pandemic, as these two countries represent two extremes of ‘COVID-19 related mortality rates within Europe (Dong et al., 2020).

In more detail, the following sub-research questions will be investigated with the aim to highlight salient information for govern of pandemic crisis by public agencies:

- How does the severity of the crisis and the mortality it causes affect respondents’ time spent for information search on pandemic related subjects?
- How does the severity of the crisis affect the trust placed in official government sources?

- What role do the level of severity in corresponding country, respondents' risk perception and information behavior play in the willingness of vaccination against COVID-19?

The COVID-19 pandemic is unprecedented in its severity and the way it has affected not only people of a few countries or continents, but rather the whole of humanity all over the globe. Accordingly, this study wants to answer the research questions in two cohorts of respondents, from Germany and Italy respectively, in order to understand how the differences of the countries, particularly in relation to the level of severity of the outbreaks of COVID-19, might influence information behavior. Consequently, the following section describes the background about the topic and the third one illustrates the methodology employed - whose results are reported in the fourth section. In the fifth section, we elaborate on the limitations of the survey before discussing the results in the sixth section. Lastly, the conclusion can be found in section seven.

2. BACKGROUND

2.1 Institutional Communication and Crisis Management

The COVID-19 crisis, floating between lockdown impositions and the need for affordable information to reduce infection rates, led to an unprecedented increase in the use of information channels (such as media, broadcasts and web newspapers) by the population. Accordingly, as of early February 2020, the risk of being inundated with fake news from unreliable sources posed a serious problem in managing the pandemic crisis, threatening to exacerbate the danger of the virus and posing even greater problems for governments. As a result, health care facilities and public agencies around the world acted as providers of information aimed at educating citizens about best practices, reasons for personal restraints, concerns, and correct behaviors to better combat the spread of infections. In this sense, it is important to analyze the role of communication in health crisis by examining how the population understands institutional proposals and constraints. To this end, communication with citizens becomes a lever for the effectiveness of public interventions (Osborne & Strokosch, 2013).

With an unprecedented large portion of the population working from home (Naidoo, 2020) and extremely high social media use (Bick et al., 2020; Farooq et al., 2021), it was incumbent upon the government to quickly implement innovative and unconventional communication strategies capable of reaching these (mostly younger and rather technology-oriented) segments for a co-productive system (Cepiku & Giordano, 2014). The management of the COVID-19 pandemic required rapid intervention aimed at educating people without causing panic (Cowper, 2020). Smith (2006), referring to the first SARS crisis, noted the lack of evidence of the relative role of the media, government or other entities in intensifying public debate about the risk of an epidemic and reassurance about its solutions. Different strategies were carried out: China, for instance, took an authoritarian approach to downplay the severity of the outbreak in its early stages. Other countries behaved differently, in line with the WHO strategies for Risk Communication and Communication Engagement (RCCE). These guidelines (World Health Organization, 2020) helped to combat the effects of an excessive amount of information about a problem (which can lead to difficulties in identifying the right solution), strengthen loyalty in response, and increase the likelihood of improving health literacy (Viola, Toma, Manta, & Benvenuto, 2021).

Accordingly, worldwide and supranational organizations took various actions to address the COVID-19 outbreak, including public access to disease data and transparency of government responses to the pandemic (Gao, Zhang, Wu, & Wang, 2020). Comfort, Kapucu, Ko, Menoni, and Siciliano (2020) noted that collective awareness, amplified by timely, valid communication, enables coordinated actions needed to bring the crisis under control. In this context of "information hunger" of citizens, the world of social platforms has exploded so much in the population that it encourages public institutions to use social networks to promote debate on the pandemic, in order to mitigate the risk of fake news as well as encouraging multiple points of view in crisis management (Viola et al., 2021). Nevertheless, the constant overload of (often conflicting) information through different channels at all times of the day seemed to discourage some people from trusting institutional channels and national newspapers with verified sources more than news disseminated through

social networks. This fact, as we can see in the following subsections, has implications for the communication themes of “topic fatigue” (Kuhlmann, Schumann, & Wolling, 2014) and “rally-around-the-flag-effect” (Chowanietz, 2011; Lee, 1977). From the very beginning, one of the most troubling concerns for public agencies related to the COVID-19 emergency has been the risk of misinformation and the resulting potential to engage only with affected communities (World Health Organization, 2020). Accordingly, given that home and hospital treatment depends on the structural capacity of the health care system to respond to the number of severe cases that occur, prevention strategies aimed at raising citizens’ awareness of the risks of contracting the virus (Rosa, Marolla, & Benvenuto, 2020) have been crucial to pandemic management. However, Bennett and Pfetsch (2018) highlighted two relevant issues with these communication policy-based prevention strategies: i) the proliferation of social and digital media, which has increased the dispersion of institutional sources (Dahlgreen, 2005), ii) the fragmentation of the public that has led to an “inability to communicate across differences” (Waisbord, 2016), including adolescents. In addition, recent studies have shown that it is difficult to prevent infection rates through Internet sources (Hernández-García & Giménez-Júlvez, 2020), because of the difficulty in providing high-quality and affordable information. Accordingly, Chundakkadan and Ravindran (2020) demonstrated that a higher flow of information about COVID-19 resulted in a lower rate of reported positive cases. Their findings suggest that the inclusion of institutional Internet-based communication channels is an important factor in enriching diverse audiences in the fight against the pandemic crisis. This means that public health agencies should begin to adapt risk communication strategies to meet the challenges of a dynamic news environment. (Kott & Limaye, 2016)

In this scenario, perceived knowledge plays an important role in risk perception. Zhu, Wei, and Zhao (2016) stated that people with higher perceived knowledge are more likely to perceive higher risks. Schäfer (2020), however, focusing on the social media sphere, argued that many posts on social network only increase perceived knowledge, which is very different from actual knowledge. In addition, the most educated people tend to adopt best practices for crisis management at the individual level; in particular, health literacy plays an important role in health protection (Kickbusch, 2001; Kim, Kim, & Lee, 2005; Nutbeam, 2000; van der Heide et al., 2013), and, recently studied, also with the willingness to get vaccination (K. Wang et al., 2021). Young people in particular have recently become more alert and concerned about public issues, including health. This is mainly due to the ability to absorb good information and knowledge, which depends more on education than age (Benvenuto, Avram, Sambati, Avram, & Viola, 2020). Accordingly, Viola et al. (2021) hope for further studies on institutional communication strategies, because since the beginning of the emergency, public institutions, both at the central and local levels, have been a key player in crisis management, especially in the implementation of health and social policies to prevent the spreading of the virus.

Against this background, this study aims to contribute to the debate on crisis management through communication strategies by starting from the analysis of young people’s information consumption during the two main pandemic waves. Since information flow seems to influence the rate of contagion (Chundakkadan & Ravindran, 2020), we focus on two populations (with similar sociodemographic characteristics) from Italy and Germany, where the severity of pandemic was very different.

2.2 The Italian and German Context

Many countries have successfully reduced their COVID-19 infection rate early (e.g. Germany and Austria (Bilinski & Emanuel, 2020; Stafford, 2020; Villani, McKee, Cascini, Ricciardi, & Boccia, 2020)) while others have been overwhelmed (e.g. Spain and Italy (Del Buono, Iannaccone, Camilli, Del Buono, & Aspromonte, 2020; Indolfi & Spaccarotella, 2020; The Lancet Public Health, 2020)). The reasons for these differences are complex, but are generally attributed to the speed and magnitude of governmental intervention and how communities have received, perceived, and acted on the information provided by public agencies (Hyland-Wood, Gardner, Leask, & Ecker, 2021). Italy has had one of the worst responses to the COVID-19 outbreak globally, with deaths per capita being a lot higher there than in most other European countries. As of 30.05.2021, per 1 million Italians, 2,090 had died because of COVID-19 (Dong et al., 2020). In comparison, in the same time

frame, Germany only suffered 1,067 deaths per 1 million, and other European countries such as France (1,634), Austria (1,197), Spain (1,703) and Switzerland (1,265) have, thus far, also been more successful in dealing with the pandemic (Dong et al., 2020). Thus, a comparison of a German and Italian sample stands for a comparison of two countries within Europe, which are at two opposite ends of a severity-scale, i.e. having a very high vs. a very low level of severity, measured in deaths in connection with COVID-19.

The following figures 1 and 2 show the level of infections and deaths, in total and per month, in Germany and Italy. It is easy to note that, for a similar rate of infection, the death rate in Italy is much higher than that in Germany in both waves of the pandemic (Feb-Mar 2020 and Oct-Dec 2020). Especially the spike in COVID-19 related deaths in Italy during March and April 2020, as visible in figure 2, is an important difference between the two countries that is part of the basis for the research in this paper.

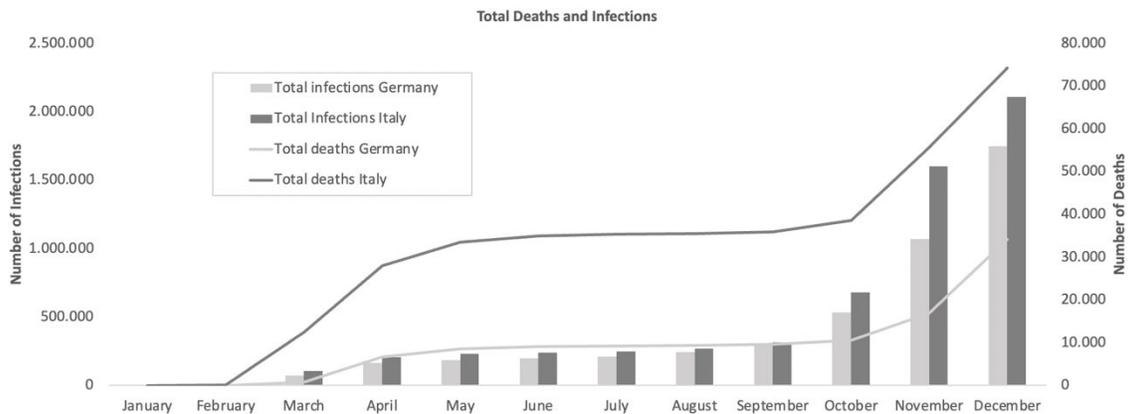


FIGURE 1: Total deaths and infections per month in Italy vs. Germany (own elaboration). Data from Dong et al., 2020.

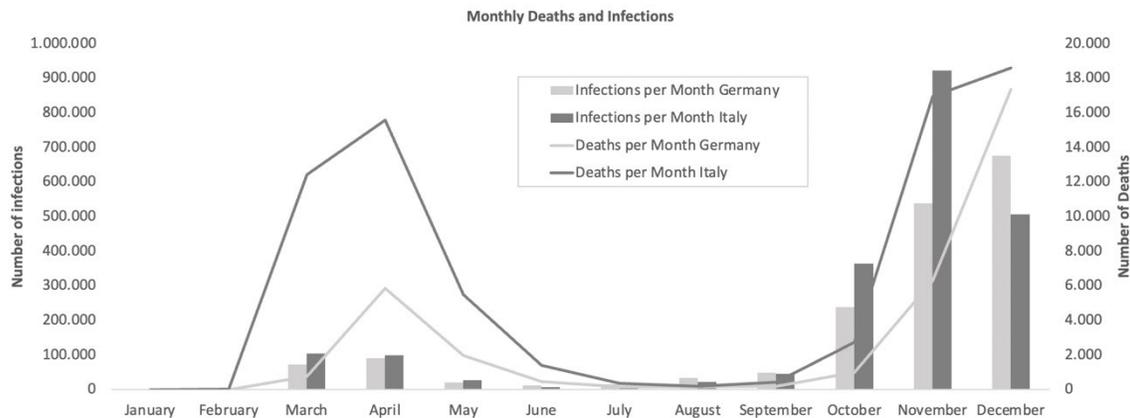


FIGURE 2: New monthly deaths and infections in Italy vs. Germany (o Own elaboration). Data from Dong et al., 2020.

This paper could not understand the clinical reasons for the presented results but wants to research if there are any connections between the infection rate and the way people inform themselves during a crisis situation. Moreover, focusing on the comparison of perceived threats posed by COVID-19 among Central European countries, other works reveal that German and Italian citizens feel a lesser and higher threat from the pandemic respectively (Perrotta et al., 2021). This makes the two countries particularly interesting candidates for comparison. Accordingly, the effective

communication during a public health crisis would be defined as “*an interactive process of exchange of information and opinion among individuals, groups, and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk, that express concerns, opinions or reactions to risk messages or legal and institutional arrangements for risk management*” (National Research Council, 1989). Television and printed news media must now compete with a vast array of easily accessible social media, online news and opinion sources (Hyland-Wood et al., 2021). In particular, social media is highly engaging and encourages users to share contents (Dobson, Robards, & Carah, 2018). In recent years, the use of social media platforms (e.g., Facebook, Twitter, LinkedIn, Weibo, WeChat) from government and entities (e.g., UN and WHO) for crisis communications (e.g., natural disasters, weather events, and criminal/terrorist events) has increased (Q. Chen et al., 2020; Guo, Lu, Kuang, & Wang, 2020). Governmental use of social media during crises may bring benefits such as improving people’s crisis awareness and understanding, facilitating emotional relief as well as controlling crisis rumors.

On the other hand, however, internet-based sources also have the ability to negatively impact people’s wellbeing, both in terms of physical and mental health (Farooq et al., 2021). They do so by fostering information-overload and cyberchondria (which are both negatively correlated to self-isolation intention). Moreover, misinformation about COVID-19 is prevalent in social media as the pandemic unfolds, and the associated risks are extremely high. Misleading information about the pandemic has been widely disseminated in digital spaces, and in some cases, even promoted by public figures, including celebrities and politicians (Ayoub, Yang, & Zhou, 2021). Accordingly, the use of social media as an information source has been widely criticized. Lay people tend to share subjective opinions and, occasionally, even misinformation - which at times can be challenging to distinguish from valid evidence-backed information (Del Vicario et al., 2016).

2.3 Topic Fatigue

All the previous issues lay the foundation for another phenomenon called topic fatigue. First introduced by Kuhlmann, Schumann and Wolling in 2014, topic fatigue is defined as “*the cognition that recipients do no longer want to hear nor see anything about a topic*” (Kuhlmann et al., 2014).

Topic fatigue has been the focus of many recent scientific works (Lilleholt et al., 2020; Meichtry, Sugden, & Barnett, 2020; Michie, West, & Harvey, 2020; Zhao et al., 2020) and, over the course of the pandemic, even received a new name for these extraordinary times: pandemic fatigue. Schumann finds that one of the potential outcomes of topic fatigue is “*mistrust in media systems and journalists*” (Schumann, 2018) as well as the fostering of “*political alienation*” (Schumann, 2018). As already mentioned, social media has become the main information source (Bick et al., 2020) during the pandemic - causing an information overload, which could potentially elicit psychological ill-being caused by the use of social media (Maier, Laumer, Eckhardt, & Weitzel, 2015; Maier, Laumer, Weinert, & Weitzel, 2015). As a consequence, according to Liu et al. (2021), perceived pandemic information overload on social media increases social media fatigue and fear of COVID-19, which in turn influences people’s intention to leave social media, due to psychological discomfort (Koole, Van Dillen, & Sheppes, 2011). Interestingly, there exists a gap in literature concerning the influence of the severity of, and mortality caused by, the pandemic on topic fatigue. Do participants lose interest quicker if they are more exposed to the virus? This paper aims to investigate this by comparing the information behavior of respondents from Italy and Germany.

2.4 Rally-around-the-flag Effect

The “rally-around-the-flag” phenomenon first introduced by Mueller in 1973 refers to the often-observed effect that, in times of crisis, people often place more trust in their government and are, for example, more likely to reelect their current president (Chowanietz, 2011; Lee, 1977). These crises are, however, usually of military nature. The pandemic, while not an event of military nature, has been assumed to have a similar effect (Baekgaard, Christensen, Madsen, & Mikkelsen, 2020; Devine, Gaskell, Jennings, & Stoker, 2020; Hegewald & Schraff, 2020; Sibley et al., 2020). In fact, the opposite may also be true: How and with what measures a government tries to fight the pandemic and keep its citizens safe could negatively affect the people’s trust in their government if

the government and its representatives do not appear to fully embrace the measures themselves (Broadbent, 2020). The duration of the crisis also plays a critical role in this. Accordingly, Rieger and Wang found that, among other things, *“a smaller number of deaths [caused by COVID-19] increase the trust in governments”* (Rieger & Wang, 2020). Moreover, some scholars (Castro & Guccio, 2020; Lovari, 2020) found Italians generally have little trust in their politicians and institutions. Based on the mentioned theories and authors, we could draw two possible conclusions: either, the lower impact of pandemic in Germany has led its citizens to place more trust in their government. Or, on the contrary, the worse crisis in Italy has led to a more pronounced rally-around-the-flag effect, resulting in a higher level of trust in the national government in Italy compared to Germany. To investigate this phenomenon in the two surveyed countries and make the results as reliable as possible, this research has to consider that the base-levels of trust in their respective governments are already different between citizens of Germany and Italy. This will be also investigated in this paper by comparing the results of respondents from the two countries; this research aims to find out if the rally-around-the-flag effect is present and if it is stronger than the increase in trust caused by good crisis management.

2.5 Vaccine Hesitancy and Information

According to Khubchandani et al. (Khubchandani et al., 2021), individuals living in rural areas, with lower incomes and lower levels of education, were more likely to be hesitant about getting immunized with a COVID-19 vaccine (vaccine hesitancy). Vaccine hesitant people were more distrustful of scientific expertise and health and government authorities: these individuals were less likely to consume, and trust, information from ‘traditional’ sources (i.e. newspapers, television, radio, and government agencies) and were somewhat more likely to obtain information from social media channels, which is consistent with global trends about reporting on social media as an instrumental platform for anti-vaccine messaging. (Kata, 2012; Tangherlini et al., 2016)

Jun, Yoo & Lee demonstrate the human behavioral changes and impacts on public awareness of COVID-19. They found a correlation between a higher level of information among a country's citizens and a better ability to fight the virus, especially through vaccination (2021); Wang et al. found that *“the primary care sector should also be engaged in health education to increase vaccination coverage”* (K. Wang et al., 2021). Kourlaba et al. found that a *“higher knowledge score regarding symptoms, transmission routes and prevention and control measures against COVID-19 was significantly associated with higher willingness of respondents to get vaccinated”* (Kourlaba et al., 2021).

These findings indicate, in order to effectively fight the pandemic through vaccinations, a country has to make sure to inform its citizens sufficiently. This will help increase the acceptance and willingness of the population to get a vaccination when offered the possibility. How this willingness is influenced by the pandemic situation in a country, based on the severity as well as the perception of risks its citizens have, will also be evaluated in this work. There could be inferences between the time spent looking for information and the development of trust in official sources; this aspect should be considered as critical in order to provide an outlook about how effectively fighting the pandemic in the future through the correct general information of citizens.

2.6 Hypotheses

Based on the insights from the previous sections, the following three hypotheses are developed to evaluate the occurrence and validity of the described phenomena as well as to answer the proposed research questions:

H1: People in a country with a higher severity / mortality rate for people infected with COVID-19 inform themselves more about the virus than people living in a country with a lower severity.

H2: The trust in official government sources is lower in a country with a higher severity / mortality rate for people infected with COVID-19 than in a country with a lower severity.

H3: The willingness to be vaccinated is influenced by the severity of the crisis as well as the perception of the risk of the crisis by the respondents.

To further dive into hypothesis 3, we have devised 3 sub-hypotheses which more clearly define the correlations this paper investigates:

SH1: The better people feel informed about the virus, the higher is their willingness to get vaccinated when possible.

SH2: The higher the severity and mortality caused by the virus is in a country, the higher is the willingness of its citizens to get vaccinated.

SH3: People who are more afraid of getting ill themselves or of relatives getting ill are more willing to be vaccinated if this is possible.

The hypotheses, and sub-hypotheses, will be answered through comparing the results between the two countries.

3. METHODOLOGY

3.1 Survey Design

In order to answer the previously introduced research question, the authors ran a quantitative online survey (Shehata, 2020; Yin, 2014) aimed at discovering the information consumption among the young German and Italian population in relation to the severity of the pandemic in the two countries following the two waves of infections in 2020. Two questionnaires were used, both featured the same questions, with the only difference being the language in which the survey was designed and distributed. The German part was distributed through the mailing-list at the University of Applied Sciences in Neu-Ulm and students were also asked to share the survey with friends and fellow students. Therefore, respondents were mostly students at the mentioned university. The survey had 92 respondents, of which 67 finished the survey completely. The second, Italian sample consisted mostly of students and former students from the Tor Vergata University of Rome. It was also distributed through official channels as well as word of mouth by the students. In total, 70 students took part in the Italian survey, with 55 of them finishing it. The surveys were open for answers from 8 to 23 December 2020 in both Germany and Italy.

While the language may have been different, the contents and (translated) wordings were identical in both samples. Both included 10 questions, 6 of which were demographic questions, with the remaining questions all being relevant to answer the proposed hypotheses and research question. The four relevant questions, however, were not simple polar questions offering the answers yes and no, but were rather complex rating questions including a multitude of different statements as well as sub-questions. The whole questionnaire is presented in the appendix. The four relevant questions, as well as the corresponding variables we designed to evaluate the proposed hypotheses and answer the research questions are listed in table 1.

Hypothesis	Question	Variable
H1	„Please estimate your daily average of news consumption about the coronavirus at the moment.“	Daily news consumption 5 different answering options ranging from „less than 5 minutes“ to „more than 2 hours“.
H1	„Please tick the box corresponding to how much you informed yourself about corona in the past months. There are some events in Italy noted next to the months as small reminders.“	News consumption per month Answering options on a 4-point Likert Scale ranging from „inform myself a lot“ to „Don't inform myself“.
H2	„How trustworthy are the following sources of information for you?“	Trustworthiness of governmental sources. Answering options on a 5-point Likert Scale ranging from „very trustworthy“ to „not trustworthy at all“.
H3	„In the following you will find a number of statements. For each statement, please tick the extent to which you agree with it. (randomised)“	Agreement with 14 different statements. Each statement has answering options on a 5-point Likert Scale ranging from „I totally agree“ to „I do not agree at all“
SH1	1. „I feel well informed about the Coronavirus 2. „I believe that we can cope with this disease in our country“	1. Informedness 2. Optimism
SH2	1. „I will get vaccinated when I get the possibility to do so“	1. Vaccination Willingness
SH3	1. „I'm afraid that people close to me will get seriously ill“ 2. „I'm afraid that I myself might become seriously ill“	1. Perceived risk of infection

TABLE 1: Questions relevant to the hypotheses.

Similarly to the work done by Rieger and Wang (2020), we used a balanced 5-point Likert Scale for the answering options, except for question 4, where we ask for the respondents' self-assessment of information behavior with compulsion to a tendency (rather much or rather little). With the above questions, the study investigated the time respondents spent informing themselves about COVID-19 (and how that time had changed over the course of the pandemic), the channels they use and how much they trust them as well as their agreement, or disagreement with a multitude of statements, designed to allow the authors to look for correlations between, for example, the fear of being infected and the willingness to receive vaccination when offered the possibility.

3.2 Structure of Respondents

On average, the respondents of the Italian sample were older than those of the German sample - the most frequently occurring age range being 25-29 years old - as opposed to 20-24 for the German participants. Most likely caused by the higher age average, the highest level of education completed was higher among the Italian respondents. Most of them (36%) had achieved a Master's degree. Among German participants, the most frequent degree is the high school diploma („Abitur“), with 58% having achieved it.

Most respondents are female in both of the two samples: 70% of German respondents, 57% of Italian respondents. This is in line with other studies (Perrotta et al., 2021), which also had a disproportionately high percentage, about 67%, of female respondents. As demonstrated by other works as well, women appear to be more willing to be informed and interested in health-related issues, especially if concerning to digital technologies and innovation implementation (Bender et al., 2014; Xie, Nacioglu, & Or, 2018). As a consequence, women are more inclined to share their experiences (Kanstrup, Bertelsen, & Nøhr, 2015; Ryan & Sysko, 2007) which explains the higher portion of female respondents in many surveys.

3.3 Analysis Procedure

SPSS software is used for the analysis, with different procedures depending on the hypotheses considered and the underlying data: To test hypothesis 1 and the third sub-hypothesis of hypothesis 3, cross tables are created as they are able to reveal stated differences between Italy and Germany.

Their significances are calculated on the basis of Chi-square. Mean comparisons with T-tests are carried out to test hypothesis 2 and the second sub-hypothesis of hypothesis 3. Lastly, Pearson's correlation coefficients are conducted to prove the first and third sub-hypothesis of hypothesis 3. The condition for performing T-tests and correlation analyses that the underlying data are metric is fulfilled because the involved questions are based on a balanced Likert scale allowing an interpretation of being interval scaled (Halme, Joro, & Koivu, 2002). Furthermore, a multiple variance analysis is undertaken to finally clarify which of the factors tested in connection with the third hypothesis is ultimately more relevant for the vaccination decision: the country (Italy vs. Germany) and thus the severity of the pandemic or the level of feeling well-informed.

4. RESULTS

4.1 Hypothesis 1

Hypothesis 1 is tested in two steps. First, the results of the individual estimation of the current daily average of news consumption about COVID-19 are compared between Italy and Germany:

The results are very similar. In both samples, by far the largest proportion of respondents (I: 51.1%; G: 50.0%) informed themselves for "5 to 20 minutes" per day. The second-highest share is attributed to the category "less than 5 minutes" a day (I: 23.4%; G: 34.8%). Only a minority spends more than 20 minutes a day with news consumption about COVID-19 in both countries. According to this analysis, there are no significant differences in information behavior between Italy and Germany. However, we should keep in mind that the proposed answer category "5 to 20 minutes" per day includes a relatively broad range: It makes a difference whether someone spends 5 or 20 minutes a day looking for information.

On closer inspection, however, differences do emerge in the course of the year 2020: Participants were also asked to rate their information behavior for each month of 2020, offering a 4 point Likert scale, with answering options ranging from "1=inform myself a lot" to "4=don't inform myself at all". This forced-choice scale (based on 4 scores instead of 5) was intended to ensure that participants must at least tend to assess their information behavior without presenting an answer option that makes respondents too comfortable.

To achieve a clearer presentation of the data, the possible answering categories have been combined into two options: "inform myself much", made up of the options "inform myself a lot" and "inform myself rather much", and "don't inform myself much", made up of the remaining two. The results of participants informing themselves "much" are displayed in figure 3. It is apparent that Italian participants tend to always inform themselves more than the German participants, especially during the respective beginning of the first and second wave. During the peaks of the two waves, in March and November / December, information behavior is almost identical. The related Chi-square tests show significant ($p < 0.05$) differences in information behavior between the two countries in June and in the period August to October.

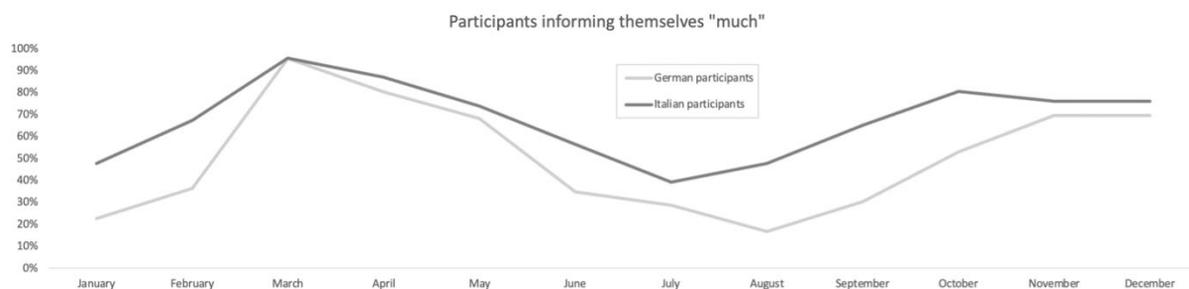


FIGURE 3: Participants informing themselves "much" per month.

Based on this data, hypothesis 1 can be partially proven: While Italian participants did not inform themselves more at all times, there are considerable and significant differences during the summer months (despite July) where infection rates were rather low.

4.2 Hypothesis 2

To evaluate hypothesis 2, the survey includes one question asking participants to indicate the trustworthiness of different channels on a 5-point Likert scale, ranging from “1=very trustworthy” to “5=not trustworthy at all”. Among other channels, respondents assessed the trustworthiness of “websites/posts/tweets from government sources”. As already mentioned, the scale allows the calculation of means and thus also a check of significance using a T-test.

Surprisingly, the Italian respondents trust information from their government even more than the German participants do. The mean trustworthiness of government sources as an information source in Italy is 1.53 and thus relatively close to the best possible value of trustworthiness, which is 1. The trust in government sources, with a mean of 1.91, is also relatively high in Germany but significantly lower ($p=0.02$) in comparison.

As a result, not only must hypothesis 2 be rejected, but the opposite is found to be true: The Italian respondents, living in a country with higher COVID-19 mortality rates than Germany, indicate that they trust their government sources even more than the German respondents

4.3 Hypothesis 3

To investigate the correlation between respondents' willingness to get a vaccination and other factors, the survey includes a number of statements. Respondents are asked to indicate their agreement – or disagreement – with these statements on a 5-point Likert scale, ranging from “1=totally agree” to “5=totally disagree”. Then, correlations between different statements are calculated.

SH1 assumes a correlation between the feeling of being well-informed about COVID-19 and the vaccination willingness. The existence of this correlation turns out to be true: In Germany the Pearson's correlation coefficient is 0.26, which indicates a rather moderate strength (Cohen, 1988), but it is significant ($p=0.03$). In Italy, the correlation is of higher strength (0.36) and even of higher significance ($p=0.01$) at the same time. As the correlation is significant in both countries, this sub-hypothesis can be confirmed.

According to SH2, the vaccination willingness is expected to be higher in Italy than in Germany. The average agreement to the statement “I will get vaccinated when I get the possibility to do so” in Italy, still based on the above-mentioned 5-point scale, is 2.13, thus close to the level “rather agree”. In Germany, however, the corresponding value of 2.95 indicates a higher level of vaccination skepticism and is close to the scale value “undecided”. Additionally, the difference of these mean values is highly significant with $p = 0.002$. Therefore, SH2 can be verified as well.

The last sub-hypothesis assumes that there is a connection between a person's concern that he/she himself/herself or a close person could become seriously ill and his/her vaccination willingness. Interestingly, the connection between fear of the disease and vaccination willingness is completely different in both countries: There is absolutely no connection between the fear of becoming ill oneself and vaccination willingness in Germany. In contrast, there *is* a significant correlation in Italy: Pearson's correlation coefficient is 0.3 (moderate strength) with a p-value of 0.04. We might assume that the non-existence of an impact of the fear of becoming ill in Germany is because the fear itself is lower or almost absent there because mortality rates are much lower than in Italy. In fact, the cross table making a comparison of the assessment of the statement “I'm afraid that I myself might become seriously ill” between Germany and Italy shows a corresponding tendency. In figure 4, the table is displayed in the form of a diagram :

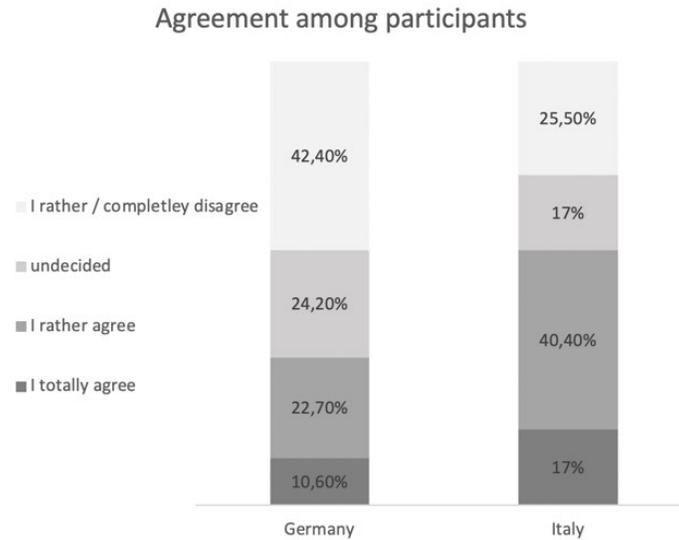


FIGURE 4: Assessment of the statement “I’m afraid that I myself might become seriously ill”, Proportions of mentions in Germany vs. Italy.

Obviously, the fear of getting seriously ill with COVID-19 is much more pronounced in Italy than in Germany, where 42% are rather carefree in this regard. The related Phi-value is 0.24 and thus represents a moderate connection. The Chi-square independence test provides a significance level of $p=0.08$, which is hard on the border of being significant. Nevertheless, this correlation between fear of getting ill and the country could partly explain the different impact of the fear on the vaccination willingness.

The correlation between the fear that people close to oneself could become seriously ill in Italy is even stronger, given a value for Pearson’s coefficient of 0.43 and a higher significance ($p=0.003$). However, there is again no significant correlation in Germany, but at least higher than in the context of fear that oneself could become seriously ill. In contrast to the findings above, there are no differences noteworthy referring to the statement “I’m afraid that people close to me might become seriously ill” between Italy and Germany. While 47% of the Italian respondents totally agree with this statement, 44% of the Germans do. Nonetheless, this variable does not affect the vaccination willingness in both countries, but only in Italy. Overall, the results lead to the conclusion that SH3 is verified only for Italy and must be rejected for Germany.

In summary, the question arises, which of the analyzed factors are most important, or at least more important than others, for the willingness of getting vaccinated. For this purpose, a multi-factor

variance analysis is conducted with the vaccination willingness as the dependent variable. The output table is shown in table 2:

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	48,090 ^a	9	5,343	3,233	0,002	0,220
Intercept	200,864	1	200,864	121,147	0,000	0,540
Country	7,207	1	7,207	4,347	0,040	0,040
Level of informedness	17,640	4	4,410	2,660	0,037	0,094
Country * level of informedness	6,476	4	1,619	0,977	0,424	0,037
Error	170,777	103	1,658			
Total	989,000	113				
Corrected Total	218,867	112				

a. R squared = ,220 (Adjusted R Square = ,152)

TABLE 2: Results of multi-factor variance analysis: Tests of between-subject effects with dependent variable "Vaccination willingness".

Of the factors presented here, only two factors were able to make a significant explanatory contribution to vaccination willingness: The country, i.e. Italy or Germany on the one hand and the level of informedness (feeling of being well-informed) on the other hand. It has been already shown that the more a person has the feeling of being well-informed, the more he/she is willing to get vaccinated. Above that, respondents in Italy show a higher willingness to get vaccinated than the German sample. The model itself is obviously highly significant ($p=0.002$). As a whole, the model shows an eta square of 0.22 which corresponds to an effect size of 0.42, representing a strong effect according to Cohen (Cohen, 1988). The factors "country" and "level of informedness", are both significant and thus have an impact on the vaccination willingness. However, the partial eta squared values, show that the impact of the level of informedness is higher (0.094) than that of the country (0.040). Following Cohen, the level of informedness even has a strong effect on the vaccination willingness, while the effect by the country is moderate.

4.4 Summary of Results

In table 3, we compiled all results to grant an easy overview of the previously proposed hypotheses as well as the corresponding findings.

Variable	Summary of Findings	Confirmed or Refuted
H1: People in a country with a higher severity / mortality rate for people infected with COVID-19 inform themselves more about the virus than people living in a country with a lower severity.	While not true at all times (e.g. the peaks of the first and second wave), Italian respondents do tend to inform themselves more overall.	Partly Confirmed
H2: The trust in official government sources is lower in a country with a higher severity / mortality rate for people infected with COVID-19 than in a country with a lower severity.	Italian Respondents actually placed more trust in their government than German respondents.	Refuted
H3: The vaccination acceptance is influenced by the severity of the crisis as well as the perception of the risk of the crisis by the respondents.	Information and Severity do seem to influence vaccine acceptance. Fear, however, only seemed to influence the decision of Italian respondents.	Partly Confirmed
SH1: The better people feel informed about the virus, the higher is their willingness to get vaccinated when possible	Respondents who perceived themselves as being well informed were more likely to accept a vaccination when offered	Confirmed
SH2: The higher the severity and mortality caused by the virus is in a country, the higher the willingness of its citizens to get vaccinated.	People who are more afraid of getting ill themselves or of relatives getting ill are more willing to be vaccinated if this is possible. Italy has had a undoubtedly worse outbreak of the pandemic, and Italian respondents were more willing to accept a vaccination.	Confirmed
SH3: People who are more afraid of getting ill themselves or having relatives get ill are more willing to get vaccinated when possible.	While true for Italians, worry or fear did not seem to influence German respondents in either direction.	Partly Confirmed

TABLE 3: Summary of all findings.

5. DISCUSSION

Based on the conducted research, all hypotheses and sub-hypothesis could be evaluated through the work of this paper. This allows this paper to answer the proposed research question: ***How does the severity of the ongoing pandemic influence the information behavior of young people aged 18 to 35 in Germany and Italy in comparison?***

Accordingly, findings of this study can be summarized as follows: The severity of the pandemic in a given country does influence the information behavior of its citizens. Hypothesis 1 proved that, while not consistently so, information behavior over the course of the year 2020 was higher among Italian respondents at most times. This means that the severity of pandemic and feelings of fear about it have influenced the information consumption. Additionally, figure 3 illustrated that the information behavior of the two groups seemed to decline over time and did not reach a new high when a new record of infections was set in November and December (in Italy and Germany respectively). This correlates with the idea of topic fatigue introduced by Schumann (2018). Respondents are tired of hearing about the virus and the pandemic. Similar results have been found by scholars such as Lilleholt in Denmark (Lilleholt et al., 2020), Zhao et al. in the US (Zhao et al., 2020) and Petherick et al. worldwide (Petherick et al., 2021). Accordingly, these results can be useful in crisis management by highlighting that an effective institutional communication strategy should take into account that people tend to decrease its attention about a topic; thus, it can be suggestable for health institution to modify the channels and ways (Comfort et al., 2020) through which they communicate to citizens.

Hypothesis 2, however, had to be refuted entirely. German respondents did not place more trust in their government. In fact, the trust Italians placed in their government was significantly higher. This is a clear indication for a rally-around-the-flag effect in Italy and confirms findings by other scholars (Baekgaard et al., 2020; Devine et al., 2020; Hegewald & Schraff, 2020; Sibley et al., 2020). Even though Lovari found that Italy *“suffers from a general lack of trust in public institutions”* (Lovari, 2020), findings of the study demonstrated Italian respondents trusted their government more than Germans. While other works also found a general lack of trust in public institutions by Italians, (Castro & Guccio, 2020), they also demonstrated that the Italian public placed a lot of trust in governmental experts during the COVID-19 pandemic. These results are in line with another study by Falcone et al. which found that, during the pandemic, about 75% of Italians trusted public institutions (Falcone et al., 2020). In the authors' words: *“A pandemic like COVID-19 creates the*

preconditions for a collective case of necessary trust in public authorities, or institutional trust by force majeure: not in the sense that we are being manipulated by some hidden power, as some conspiracy theorists may be prone to believe, but because the very nature of the health crisis leaves us with no other option than to put our trust in public authorities (that is why we emphasize a need, a necessity for trust)” (Falcone et al., 2020, p. 13). Therefore, Italian citizens have no other option than to trust the relevant public institutions as a way to deal with the crisis in the form of an “civil-alliance”. (Falcone & Castelfranchi, 2001).

This finding shows that in crisis period, especially at its beginning, citizens are more willing to follow suggestions and advice from eminent institutional experts than simple rules provided by public agencies. This communication advantage should be adequately exploited by Governments in crisis management and in reducing risks for communities.

Going by the theory of the rally-around-the-flag effect, a more severe crisis leads to more trust in the government, which could be an explanation for the difference between Italy and Germany. The crisis in Germany was not as severe, therefore the government did not “earn” higher trust among its citizens. The Italian respondents do not seem to blame the government for the COVID-19 situation, but rather welcome the strict measures imposed by their government. This is also supported by the “Prevention Paradox” referred to by Rose in 2001 (Rose, 1985). By conducting a case study about a vaccine, the author found that through the successful vaccination of a population against a given disease, the awareness of that disease decreases, while the awareness of the risks associated with the vaccination itself increases. This vaccination evaluated by Rose could be compared to the restrictions put in place to fight the pandemic. An individual does not see its benefits but focuses instead on the restrictions directly affecting his or her everyday life. Similarly, an individual doesn’t see immediately the positive effect of vaccinations, but rather hears about the associated risks – even if they are much less grave. As virologist Drosten put it: “there is no glory in prevention”. (Drosten, 2020).

However, there are of course other possible explanations for the result: the demographic of the surveyed Italian respondents, for example, which mostly live in the centre of Italy, where the pandemic was less severe than in the north of the country (Dong et al., 2020). This could influence the trust in government. Accordingly, a definitive answer for how and why the findings differ so much cannot be given and further scholarly research into the different possible causes would be valuable.

Lastly, concerning the hypothesis 3, the first two sub-hypotheses could be confirmed. Those who considered themselves to be well-informed about the pandemic were more likely to get a vaccination when offered the possibility. This matches the findings of Malik et al. (Malik, McFadden, Elharake, & Omer, 2020), who linked vaccination acceptance to higher education. This result shows the need for crisis management through communication campaigns designed to inform and educate people on health issues. Knowledge of the scientific advantages and disadvantages of a vaccine (or other public safety measure) among all segments of the population forms the basis for citizen participation in managing health crises in a coproduction system. (Osborne, Radnor, & Strokosch, 2016).

Moreover, the percentage of people willing to get the vaccination was considerably higher in Italy than in Germany. This can be attributed to the higher risk of infection and bigger worry that the Italians have about getting infected with COVID-19 (as visible in figure 4). This difference in vaccination acceptance matches the findings by Barello, Nania, Dellafiore, Graffigna, and Caruso (2020), who found vaccination acceptance among university students in Italy to be around 86.1%, while two studies by Neumann-Böhme et al. as well as Lazarus et al. placed the vaccination acceptance in Germany at 70% (Neumann-Böhme et al., 2020) and 68.4% (Lazarus et al., 2021) respectively. The German studies were conducted among the whole population, however. Still, they also found Italian vaccination acceptance in general to be higher, at 77.3% (Neumann-Böhme et al., 2020) and 70.8% (Lazarus et al., 2021) respectively, for the general population. The role that fear of an, possibly deadly, infection plays in vaccination acceptance was also investigated by

Sallam (Sallam, 2021), who found that vaccination acceptance was highest in countries with worse outbreaks of COVID-19 as well as worse health care systems. The three countries with the highest vaccination acceptance were Ecuador with 97.0% acceptance (Sarasty, Carpio, Hudson, Guerrero-Ochoa, & Borja, 2020), Malaysia with 94.3% (Wong, Alias, Wong, Lee, & AbuBakar, 2020) and Indonesia with 93.3% (Harapan et al., 2020). Furthermore, studies (Murphy et al., 2021) showed that gender influences vaccination willingness, more precisely: Men are more willing to get vaccinated than women. This correlation can also be found in this study, because the average willingness to vaccinate by the male participants, with a mean of 2.3 on the agreement scale (1="totally agree" to 5="totally disagree") is higher than that of the females, who are rather undecided, given a mean of 2.8 ($p=0.059$). This tendency is present in both countries, but the willingness to get vaccinated of both genders is higher in Italy. The third sub-hypothesis couldn't be answered quite as clearly. While Italians who were worried about getting themselves or about related persons getting ill were more likely to get vaccinated, this worry did not seem to influence the German respondents' attitude towards vaccination in either way.

Especially the results for the third hypothesis carry with them a lot of valuable information about how to better deal with the COVID-19 pandemic. Most importantly, information is key. Citizens of a country need to feel that they are well-informed about the virus, so that they are more likely to accept a vaccination when made the offer. Going forward, the vaccination against COVID-19 is the most important tool to fight the pandemic and make a return to unrestricted everyday lives possible. Information is one key part to get there. Future research might focus on the channels with which the surveyed population can best be reached, to ensure that all people have easy access to the information needed to make an informed decision about their personal vaccination. Governments must invest heavily in informing their citizens in order to increase vaccination acceptance amongst the general public.

6. CONCLUSION

Before diving into the conclusion, however, we should keep in mind that the findings in this paper are not without limitations. The respondents in both samples consisted of two relatively homogenous groups of mostly students. These students mostly studied at the same university and had the same general age, which makes this paper unfit for drawing conclusions about the general public. Also, the number of participants in the two groups of respondents is limited to a relatively small sample size. While this does not pose a problem for the validity of the results, as other works have shown (Bailey et al., 2021; Ong et al., 2020; Shehata, 2020), it further limits the possibility of generalization. Nevertheless, the statistical evidence in this work proves its reliability. Finally, only two countries were analyzed by this research, meaning that the influence of political, geographical, or cultural differences cannot be excluded with absolute certainty. While comparing just two countries is not uncommon (J. Chen et al., 2020; C. Wang et al., 2020), this must be kept in mind when trying to apply the findings to other situations and / or countries.

Notwithstanding these limitations, this manuscript shows a clear correlation between the severity of the COVID-19 pandemic in a given country and the information behavior of its young adult citizens. Thus, the findings should prove useful in assisting public agencies with crisis management. Particularly, the main findings of this study can be summarized as follows:

- The severity of the pandemic in a country directly influences the level of information consumption of its citizens; the higher the perception of COVID-19 health related risks, the higher the time spent by young people (aged 18 to 35) informing themselves.
- A health crisis, just like a military one, creates a condition of necessity; thus, in pandemic times, especially when the level of pandemic severity increased and the ability to manage it grew uncertain, young people tended to place more trust in institutional "experts" about the virus, which are published through institutional channels.
- In general, German and Italian respondents behave similarly; differences in information consumption and government trust between the two countries can be justified by the severity of the pandemic.

- Young people who are more informed and educated tend to be more willing to get the vaccination against COVID-19.

These findings can be of great use to both scholars and practitioners in designing communication campaigns aimed at engaging young adults in the fight against the spread of the pandemic and its management. Particularly the study fosters the debate about relevance of institutional information in uncertain times. The COVID-19 health crisis causes a condition of necessity, which pushes people to place more trust in institutional information channels (Jun et al., 2021). The study recognizes that institutional information is a fundamental factor in guiding a country's citizens to correct behavior that will help combat the pandemic in particular and public emergencies in general. As highlighted in this manuscript, the effectiveness of tangible answers provided by public agencies to health crises (e.g. lockdown decisions, social distancing, mask wearing, vaccination campaigns, etc.) also depends on how, and via which channel they are communicated and how many difficulties there are in fully understanding them (Hyland-Wood et al., 2021). In this way, institutional communication becomes a vehicle for educating citizens and creating a culture which is recognized as a key driver of success for both private/public and profit/non-profit organizations. (Dorda & Shtëmbari, 2020)

Thus, the paper highlights the relevance of the “social-networking” field of marketing and communication as a lever for the effectiveness of public interventions (Osborne & Strokosch, 2013) in crisis management. After all, what is marketing if not the ability to enrich and inform a target audience? This is exactly what governments and public policies are expected to do to increase the effectiveness of public health interventions, such as citizen vaccination acceptance, which is a vital step on the path back to a normal pre-pandemic life. Particularly, due to an unprecedented major part of the population working from home (Naidoo, 2020) with extremely high social media usage (Bick et al., 2020; Farooq et al., 2021), it would have been desirable that the government implements innovative and unconventional communication strategies capable of reaching those segments of the population (mostly younger and technology oriented) that tend to use non-traditional information channels. Public organizations should therefore continue to invest time and resources in building a culture among citizens to address the COVID-19 pandemic.

Following the debate triggered by the work of Cristofaro et al. (Cristofaro, Giardino, & Leoni, 2021), this paper expands on the IJBRM's journey of evaluating global management mainstreams in terms of public issues. The study seeks to sketch recommendations for policymakers and public managers to encourage the provision of guidelines and practices aimed at educating and informing diverse groups of people during extraordinary times. Particularly, the importance of marketing and communication is clearly highlighted in this paper, in their interferences for the co-creation of public value (Osborne et al., 2016). Accordingly, this work could contribute to the IJBRM debate by adding a new dimension to the repertoire of published articles: Communication issues in public crisis management, discussed in terms of the current public health crisis caused by COVID-19 and its global implications.

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APPENDICES

Questionnaire

1. Are you younger than 35 years old?

- Yes
- No (Survey finished)

2. Please estimate your daily average of news consumption about the coronavirus at the moment.

- Less than 5 minutes
- 5-20 minutes
- 20 minutes to 1 hour
- 1-2 hours
- more than 2 hours

3. Please tick the box corresponding to how much you informed yourself about corona in the past months. There are some events in Italy noted next to the months as small reminders.

	inform myself a lot	inform myself rather much	Inform myself rather less	Don't inform myself
january (first cases)				
february (first school closings)				
march (strict restrictions)				
april (cases declining)				
may (most restrictions lifted)				
june (borders are opened)				
july (low new infections)				
august (restrictions on social life)				
september (new infections surge)				
october (2nd wave)				
november (massive restrictions)				
december (heavy restrictions)				

4. How trustworthy are the following sources of information for you?

	very trustworthy	rather trustworthy	undecided	rather not trustworthy	not trustworthy at all
news websites (from serious publishers)					
websites/posts/tweets from tabloid press/yellow press					

6. *What is your gender?*

- female
- male
- diverse

7. *How old are you?*

- under 15 years
- 15 to 19 years
- 20 to 24 years
- 25 to 29 years
- 30 to 34 years

8. *Where do you currently live?*

- Germany
- Italy
- Other_____

9. *What is the highest degree or level of education you have completed?*

- Secondary school certificate (Scuola Secondaria)
- High School Graduation (Liceo)
- Bachelor's Degree
- Master's Degree
- Ph. D. (Doktor) or higher

10. *Have you finished your academic education?*

- yes
- no

Evaluation of Critical Infrastructure Essential Businesses Amidst Covid -19 Using Network Optimization Models

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Abstract

This study evaluates the use of network optimization models in an essential infrastructure business during a pandemic. As per the Cyber Infrastructure Security Agency (CISA), there are 16 critical infrastructure sectors whose assets, systems, and networks, whether physical or virtual, are considered vital to the United States. Their incapacitation or destruction would have a debilitating effect on the security, national economic security, national public health or safety, or any combination thereof.

For this study, we primarily focus on the Healthcare and Public Health Sector (HPH). This branch is considered a core sector as it protects the economy from threats such as terrorism, infectious disease outbreaks, and natural disasters. This evaluation provides insights into the network optimization models used by a pharmaceutical company in administering vaccinations to its local community during the COVID-19 pandemic. The intended result of the study is to provide an optimized delivery strategy by understanding the pros and cons of the network model that is being used currently and suggest a better strategical network model if available to administrate the vaccination program safely and efficiently throughout the United States.

Keywords: Critical Infrastructure Business, COVID-19, Network Optimization Models, Pharmaceutical Industries, Supply Chain.

1. INTRODUCTION

Coronaviruses are responsible for many common colds and are transmitted in a similar way to all viruses that infect the respiratory tract, primarily with droplets of saliva or mucus and infected hands. In December 2019, the city of Wuhan in Hubei Province (China's seventh-largest city and

the 42nd biggest city in the world) became the center of a global epidemic of a new type of coronavirus, which has been officially known as severe acute respiratory syndrome (SARS) coronavirus 2 (SARS-CoV-2) or COVID-19 disease (Rothan et al.,2020). Coronavirus is the leading cause of death this year to date (05/30/2021) as per the worldometer data there have been 3,556,327 deaths and 171,010,454 active cases of the virus throughout the globe (Worldometer, 2021). However, the number of people infected with COVID-19 is higher than official statistics, as the vast majority who become infected have mild or no symptoms. Scientists are still trying to fully understand the virus and are constantly investigating the development of new vaccines and rapid diagnostics (Lamprou et al., 2020).

The World Health Organization (WHO), on 11 March 2020 announced the outbreak of COVID-19 as a pandemic. The COVID-19 pandemic is the worst after the Spanish flu pandemic in 1918 that infected one-third of the global population. Aassve et al. (2021). Scientists are still trying to fully understand the virus and are constantly investigating the development of new vaccines (Callaway et al., 2020) and rapid diagnostics (Sheridan et al., 2020). A recent report published in April 2020 has found that 94% of Fortune 1000 companies are experiencing disruptions because of COVID-19, while 75% have been negatively affected. (Supply Chain Digital, 2021). According to the report by the International Civil Aviation Organization (ICAO) in 2020 supply chain activities have been affected significantly due to COVID-19, there has been a steep decline in advancement of economy around the world. Emerging markets and developing economies went through a decline in growth over the last four financial quarters of 2020. Advanced economies have faced far more significant challenges even leading to foreclosure of businesses, (International Civil Organization, 2021), shows that the world's GDP has declined tremendously due to economic disruptions triggered by COVID-19. Indeed, the COVID-19 has affected many businesses around the world. From national lockdowns to closed borders, COVID-19 has disrupted economies and placed major strains on the supply chain and demonstrated how vulnerable the modern supply chain can be to disturbances (Zhu et al.,2020).

There have been numerous studies on network models and its positive affect on supply chain, but none of these studies come close to practicality. Craighead et al. (2007) explain the severity of disruptions in supply chain focusing on density, complexity, and node criticality. The paper explains the two main supply chain mitigation capabilities: recovery and warning but fails to provide an actual industrial scenario where disruption of supply chain has been prevented due to network models. (Gong et al., 2013). was able to explain the interdependence of network models to build a resilient supply chain network model.

In the example of 3J's trucking company (CIO insight, 2021) to restore the failure in their distribution system. The transportation team had to work around the clock to run effectively. However, the disruption of the telecommunication prevented the company to get vital information on road disruptions which caused failures in devising alternative routes. The telecommunication lines are a vital node for the trucking company, ignoring to restore them would have higher cost impact to the company both economically and with respect to time.

An examination of the supply chain literature points out the need for research on a resilient supply chain using network models. Sheffi et al. (2005). Authors such as (Snyder et al.,2006) address the disruption issue from the perspective of uncertainty of supply chain operations but none of these studies were able to capture a supply chain disruption from an in-process pandemic perspective.

This paper addresses the complexity in planning routes for delivery of Covid-19 vaccinations to pharmacies by looking at various network models while prioritizing the nodes which will help prevent disruption of the supply chain model. In this study we're primarily focusing on three supply chain models Scale Free, Random Network and Small World Network Models, these models will help us identify the critical nodes in the network, which will be used to harden the network to prevent any disruption in the delivery of Covid-19 vaccinations. The supply chain network is not only isolated to just critical nodes but also has dependency on the infrastructure

and route planning. The data for this study is provided by a leading pharmaceutical company with over 10,000 stores in its network. The study is primarily focusing in one of the main districts of the organization with 60% of the stores at a Tier4 level (\$800,000 Turnover Annually). The result from this study will help us build a framework for generating an efficient network model using a real-world scenario that will prevent disruption in the delivery of these emergency vaccinations.

2. THEORITICAL BACKGROUND

Network models are present all around us, whether it is the telephone lines that is used for audio communication, the running of appliances using residential electricity, or the mode of transportation used to get from one point to another, network models pervade daily life. Singh et al (2008). Network representation is present in so many diverse fields such as production planning, distribution, supply chain management, and resource management to name a few. During the blackout of 2003 (Electricity Consumers Resource Council, 2004) the loss of power supply caused the loss of production capacity of factories in the affected area. If the criticality of the node was identified in advance the factories could have made better decision concerning supply, inventory, and distribution. Supply chain design involves identification of configuration of network and the distribution of the resources over these networks. But how do major companies use these networks to maximize their profits? Different companies gave their own answers. Pfizer Inc (Gupta et al., 2002) modeled its distribution system as a two-echelon network which includes it two large distribution centers over its 35 third part pool distribution. Kellogg Company (Brown et al., 2001) developed an operation planning system to help determine where products are produced and how finished products and in-process products are shipped between plants and distribution centers, which reduced production, inventory, and distribution costs by an estimated \$4.5 million in 1995. There are many companies using optimization techniques to design their supply chain, such as Deere's Commercial and Consumer Equipment (C&CE) Division's inventory management system (Troyer et al., 2005), and Hewlett-Packard's supply chain (Amaral et al., 2008). There have been recent advancements in dealing with complicated network models. Pan et al., (2013) did a study on network design for agile manufacturing with multiple echelons, multiple periods, and multiple customers with heavy demand. The problem was formulated to provide an integral solution to minimize the total operational cost. (Liu et. al., 2013) addressed the same issues by using a multi-objective mixed integer linear programming (MILP) model. The beauty of network models is that it allows for the visualization and conceptualization of the relationship between components of a system. These network models can be transformed into linear programming and can be solved using computers that use algorithms and software's to optimize the results (Hillier et al., 1997).

Critical Infrastructure: As per the Cyber and Infrastructure Security Agency (CISA) there are 16 critical infrastructure sectors (Figure 1) whose assets, systems, and networks whether physical or virtual are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety or any combination thereof. Brown et al. (2006). For this study, the concentration is on the Healthcare and Public Health sector (HPH) of the Critical Infrastructure Nodes. In the year 2003, the HPH sector was inducted into the critical infrastructure sector (Walker et al.,2018), since then this sector has been protecting all the other sectors of the economy from hazards such as terrorism, infectious disease outbreaks, and natural disasters (Department of Homeland Security., 2008). A basic understanding of the networks provides a big picture of how most critical infrastructure sectors can be modeled as networks. In a network, nodes and links abstractly represent the cities and roads, telephone switches and telephone lines, or an asset and its relationship with that asset. The most surprising property of most of the network is its high concentration of assets within a boundary. This creates a vulnerability to the network from manmade and natural calamities. Network theories help to model critical infrastructure as graphs to analyze appropriate frameworks in a practical way to model and harden potential targets in a critical network (Lewis et al., 2006).

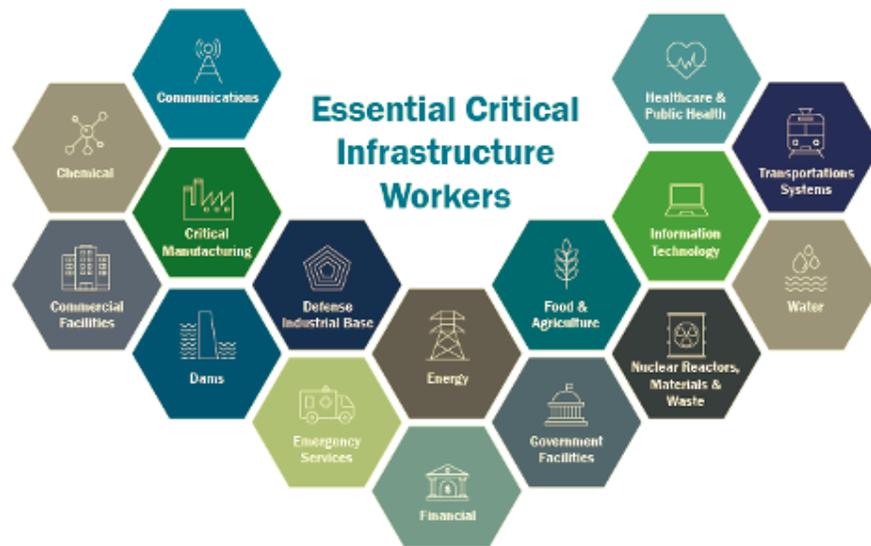


FIGURE 1: Critical Infrastructures of United States.
Source: Department of Homeland Security (2008).

As there has been limited comprehensive study conducted on this topic, a great opportunity stands ahead, to survey the administration of vaccination during the pandemic at the store level. The study primarily focuses on 10 pharmaceutical stores within a given district in the state of Illinois. The advantages of conducting research on this topic will significantly help the country to administrate the vaccination in a safe manner by identifying the network and the critical nodes within that network to prevent an active or non-active threat situation.

Pharmaceutical stores around the United States started administrating COVID-19 vaccinations from the beginning of the year 2021(Center for Disease Control and Prevention, 2021). The mission of the National Center for Immunization and Respiratory Diseases (NCIRD) is the prevention of disease, disability, and death through immunization and by control of respiratory and related diseases, to successfully complete this mission it is necessary that every individual store gets the vaccines on time for the administration of this vaccination to the customers (NCIRD., 2021). With the surge in demand and not having a sufficient supply of vaccinations, the pharmaceutical companies started creating Hub stores in each of its districts. This helped the company to coordinate the supply chain of the vaccination at a macro level but at the same time increased the vulnerability to the stores in its district. A Hub store is an active pharmaceutical store that can store and distribute COVID-19 vaccinations throughout the district and administrate the vaccinations locally to its community. Everyday professionals with the license to carry bio-hazardous equipment and samples provide a shuttle service from the Hub store to deliver all the necessary vaccination doses, equipments and documentation to the stores within that district.

2. METHODOLOGY

The flow chart below (Figure 2) shows the visual representation of the steps involved in creating a network model.

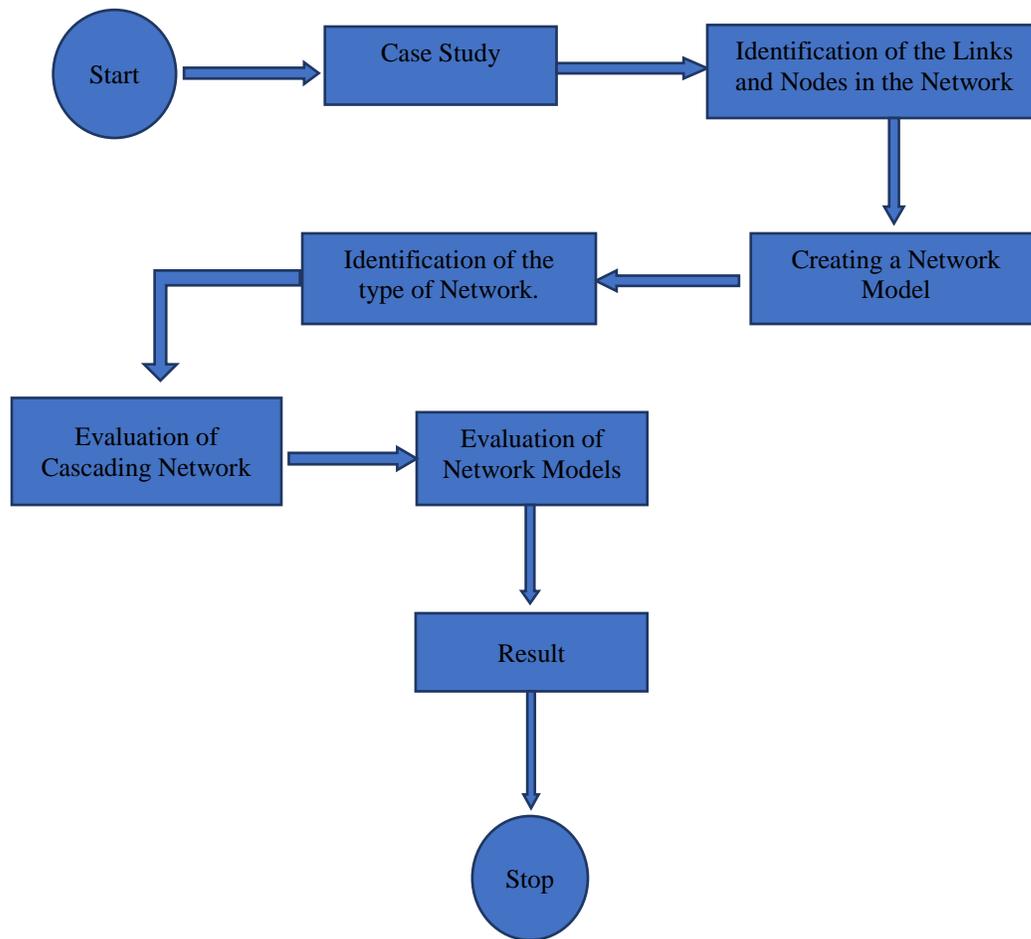


FIGURE 2: Methodology Flowchart.

This paper has been broken down to various tasks with respect to the case study. The study is being conducted in a district with 10 pharmaceutical stores in the Midwest of United States of America that administrated Covid-19 vaccinations to the local community, The location of these stores has been masked in interest of the HIPAA privacy act. There is a primary store which shuttles Covid-19 vaccinations to all the stores within that district. The number of patients being vaccinated and enrolled for vaccinations were obtained from the organization and was classified into various nodes and links, each of the links represent the actual distance between each store in the network model. Zhan et al, (2017) conducted a similar type of study where they used the dynamic node vaccination methodology to prevent the contamination of nodes in a network. The topic of vaccination within a network has been well studied with a variety of models based on different approaches. Sometimes the global solution may not be obvious, (Cohen et al.,2003) or maybe difficult to obtain (Dushoff et al., 2007) Therefore, we have used the approach of concentrating within the 10 stores in the district to complete our study. Once we have a network model created, it is essential to identify the critical nodes in the network that will prevent disruption in the supply chain of these vaccinations. Since all the nodes cannot be hardened due to economical viability, it is important to check if the model can be prevented from a cascading failure. Once the network is secured, we will look at different network model paths to provide the most effective routing for the safe delivery of Covid-19 vaccinations to all the stores within that district.

3. CASE STUDY

The delivery of the Covid-19 vaccination to the stores has become a serious issue, with only a handful of locations within the district that offers vaccination for Covid-19, but with an unending demand of people willing to get vaccinated, presents unprecedented challenges to these stores. At the time of writing this paper each of the stores that administrated the vaccination were averaging 50 doses per day of vaccinations to the local community, yet it was difficult for the people to secure an appointment for the vaccination, with no sight of appointment availability soon. This had a rippling psychological effect like that of the toilet paper incident, where people started hoarding toilet papers as a fear of scarcity in the production of toilet paper spread fear and chaos around communities during the Covid-19 pandemic. A similar fear of delay in getting the vaccination has led to people disguising as senior citizens to get access to the vaccination, even stealing the vaccination and providing saline solutions in the form of vaccination in hospitals and pharmacies. The vulnerability to the stores is higher than ever before if these issues are not dealt with seriousness. It could result in cascading failures even jeopardizing the entire presidential operation of getting everyone vaccinated before the July 4th deadline.

As it is essential for the transfer of the vaccination from the HUB store to all the other sites in the district, it is equally important to protect that specific node. If the HUB store gets affected by a human or natural cause it will have a cascading effect on the entire network as there would be disruption in the supply chain. One of the major challenges faced by the organization with delivery of the vaccination was route planning. Initially as there was only one stores within the district administrating vaccination it was easier to handle the storage and shuttling of the vaccinations. But as the number of stores started increasing, the complexity of delivering the vaccination increased. As per the CDC guidelines, if any store employee is exposed to the Covid-19 virus, the store is supposed to be closed for sanitization and the entire workforce is required to leave the store immediately to prevent further contamination. This meant that a shuttle on its route to deliver the vaccination to the store was risking the potency of the vaccination by travelling back to the hub store due to closure of the store. Other major concern with the delivery of the vaccination was the timely arrival of the vaccination to the stores. This was an issue at a store level as customers had to wait for hours for the vaccination to arrive and rescheduling of appointments was not an option. This led to people getting aggravated and even vandalizing the stores in the district. These were serious issues with respect to safety of the customers in the store. There is a need to identify the critical stores in the network and ensure an optimized route is followed to deliver the vaccination in a timely manner to these stores. The objective of this study is to provide solution to both these problems.

4.RESULT

4.1 Node & Link Identification

To identify each node and link in the network the correct location of each testing site needs to be known. Once the location is identified, google maps is used to pinpoint the location on an actual map. With the help of the map, all possible routes are created for the network. The network will represent all the potential links/arcs in the network. The following constraints have been created to chart the best routes for the delivery of vaccinations.

1. There are no toll roads taken into consideration while creating the routes
2. If two routes have the same distance, the fastest average route is taken as the primary route
3. A store can only have two other stores as a direct route.
4. There should be no isolated store (node) in the network.

Based on the constraints of the network, links that do not satisfy the constraints are removed from the network. Once all the non-feasible links are removed the actual distance between the nodes and the links are calculated.

As the location of each vaccination administrating site was shared by the organization, Google Maps was utilized to create a network model. (Figure 3).

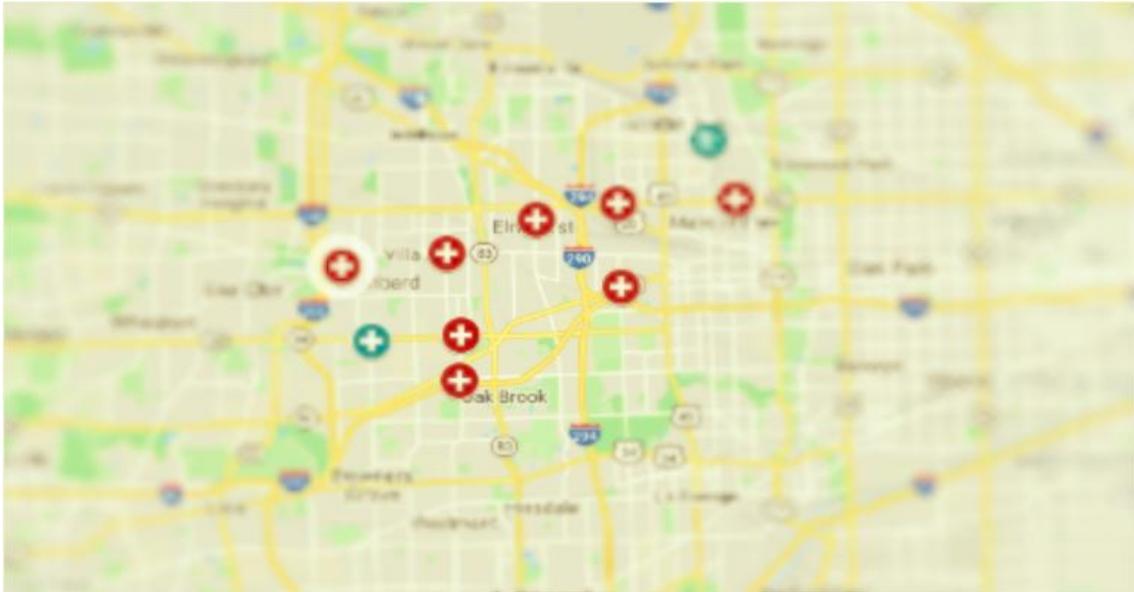


FIGURE 3: District Store Locations. Source: Google Maps.

4.2. Network Model

A network graph consists of nodes (vertices) and links(edges), nodes are the crucial points on any given network model and the links are the pathways that connect two or more nodes with each other. A path from node 'A' to node 'B' is a sequence of nodes and links that lead from 'A' to 'B'. A graph is said to be complete when every possible edge is present. A complete graph can be either a sparse or a dense graph. A sparse graph is a graph with relatively fewer links than the number of nodes present, while a dense graph consists of the greatest number of edges present in the network. The nodes and links provide a network with the mapping function. Since the locations of the stores (nodes) were shared previously using the map shown above, the network graph was created by following the constraints of the model. All distance shown in the below figure (Figure 4) are actual distances between the stores in miles.

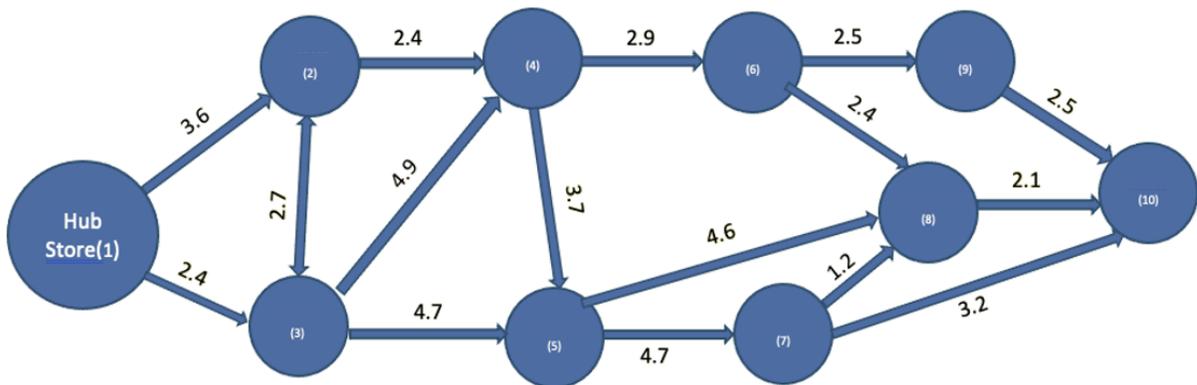


FIGURE 4: Network Graph for the District.

The network graph created is a sparse network as there are fewer than $(N-1)/2$ degrees in this graph. A degree in a graph is the number of links connected to that specific node. If a node has

only one degree, the node is considered as terminal and if the degree of a node is zero then that node is called isolated as it does not connect to any other nodes in the graph.

4.3. Type of Network

This study concentrates on three classes of networks the Scale-free, small world, and Random network model. With the help of the network model, it is possible to conduct a critical node testing for the network which helps identify all the critical nodes in the network. If the critical nodes are identified, identification of whether the network is a cascading network or not, and how to avoid cascading failures within the network model needs to be understood. Once all the models have been applied to the network, an evaluation can determine the best model for this network.

4.4. Scale Free Network Model

A scale-free network test is a simple test used to identify whether a network is a scale free network model. The test counts the number of links that are attached to each node. Once the degree of each node is determined, these degrees are divided by the number of nodes in the network. This gives the frequency of nodes for the number of links. The node's frequency is plotted as a histogram to the number of links. If the resulting histogram has a curved shape, with a rate of decline of $(1/k)^P$ where P is greater than 1 then the network is considered a Scale Free Network (Albert et al., 2009)

Degree	Frequency	Power Law	Node Count
1	0%	47%	0
2	20%	30%	2
3	40%	22%	4
4	40%	22%	4
5	0%	14%	0

TABLE 1: Scale-Free Test Table.

With the help of Table 1, a plot of the histogram graph for frequency versus links was constructed.

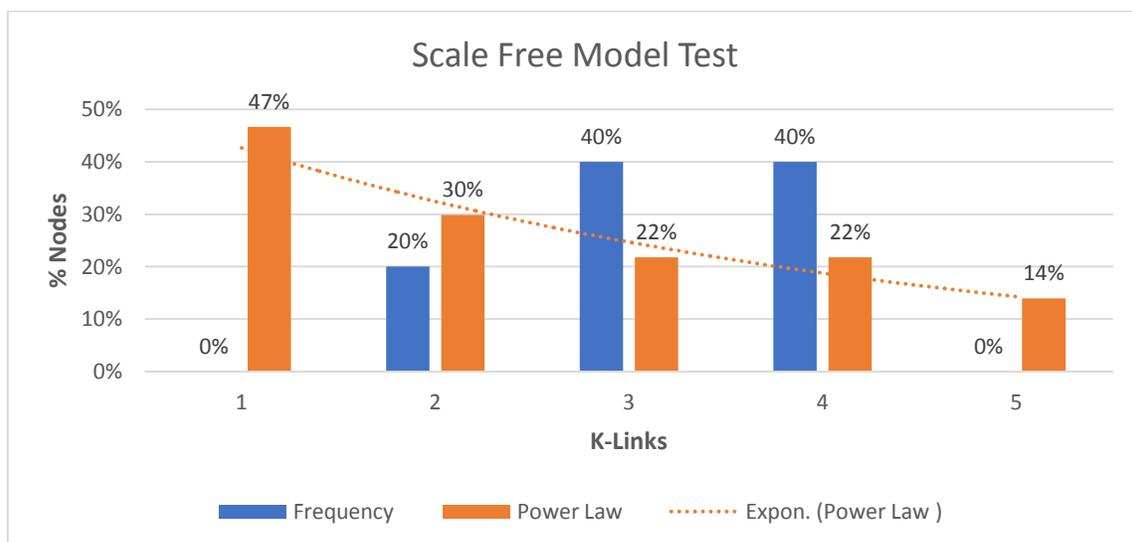


FIGURE 5: Scale-Free Test Graph.

From the graph, the following conclusions can be deduced.

1. The frequency of nodes increases with increase in the number of links
2. The most common nodes have 3 or 4 links
3. As our network does not decrease with an increase in the number of links this network cannot be classified as a Scale-Free Network.

4.5. Small World Network

As the network, created is a sparse network it satisfies one of the characteristics of a small-world network. There is a need to test the network for the remaining characteristics to check if the network is considered a small-world network.

As per Duncan Watts conditions for a small-world network are as mentioned below:(Duncan et al., 1999).

1. The network should be large
2. The network should be sparse
3. The network is decentralized
4. The network is highly clustered
5. The network is connected to every other node in the network.

For this study, the network is relatively large and sparse which satisfies the first two conditions of the small-world network. However, the network graph is not decentralized as the root node is present at the end of the network model. The network does not have a cluster formation as there are no nodes in the network that connect to every other node with the minimum number of hops. As this network does not have all the above-mentioned characteristics the network cannot be classified as a small-world network.

As the network does not fall into any of the above two mentioned classifications, it can be considered that the network is to be part of a random network model. In a random network model, the critical nodes are picked based on priorities.

4.6. Cascading Networks

Cascading failures are like epidemic when it comes to critical infrastructure models. Considering our model to be a cascade network and Covid-19 being the reason behind fault in our networks we can use this model to understand cascading failures. Let λ be the probability of the virus spreading along the links. This means that we are considering a closure of a vaccination site only due to employees being affected by the virus or a natural cause. Let χ be the store coming back to its normal function also called as the cure rate and ϖ be the stores that are dysfunctional also called as the infection rate. In a random network model cascading failure can be prevented if the spread rate (λ) which is the ratio of infection rate (ϖ) to the cure rate (χ) is less than the epidemic threshold (λ_c) of the network. In an ideal mathematical world if the spread rate is above 1 the fault will persist and continue to spread and if it is less than 1 it eventually fades away. But this is not true in the real world, there is another parameter which plays a significant role called the epidemic threshold λ_c that determines if the fault persists or dies out after a certain length of time.

$$\lambda = \varpi / \chi \quad (7.1)$$

From the above mathematical model, we can conclude that in a random cascade network, the epidemic will die out if the spread rate is less than the epidemic threshold, otherwise all the nodes will have a cascading failure. Therefore, it is important that the Hub store is protected such that λ_c is greater than or equal to λ , which will help us prevent the disruption in timely delivery of the vaccination.

4.7. Evaluation of Network Model

The network graph analysis gave the information regarding the type of network and the critical nodes in the network that could prevent a cascading failure in the network. To prevent the disruption in the supply chain of the vaccination, we can use the same network model to map out an optimized route. The following constraints helped the formation of the optimized network model.

1. The HUB node is the starting point of the network.
2. The optimized path should go through all the nodes only once

After determining the distance between each node and establishing the constraints for the network, different network optimization models are used to find the best possible route for this network.

4.8. Shortest Path Model

This model helps to achieve the shortest distance from the root node to the last node in the network. To find the shortest route excel was used to optimize the route using analytical solver. The first step is to create a table that showcases the distance of each node that has been linked to all the other nodes in the network (Table 2). In the next column, an on-route tab was created, this tab is the variable column that makes known if the path would pass through a specific node or not. If the on-route value is 1 then the path moves through that respective node otherwise it would be 0. Initially when added to this column, leaving all the on-route values to be blank. Now adding the constraint to this model, the SUMIF function is used (Table 3), here the function will look for the supply/demand of 1 unit from the root node to the final node. The net flow generated is the difference between the flow out to that of flow in, resulting in a net flow of 1 at the origin and -1 at the last node. The objective cell is the sum product of the on-route column with the distance column giving the total distance in miles for the chosen path (Table 4).

	B	C	D	E	F	G	H	I	J
3	From	To	Distance	On Route		Nodes	Net Flow		Supply/Demand
4	1	2	3.6	1		1	1	=	1
5	1	3	2.4	0		2	0	=	0
6	2	3	2.7	0		3	0	=	0
7	2	4	2.4	1		4	0	=	0
8	3	2	2.7	0		5	0	=	0
9	3	4	4.9	0		6	0	=	0
10	3	5	4.7	0		7	0	=	0
11	4	2	2.4	0		8	0	=	0
12	4	3	4.9	0		9	0	=	0
13	4	5	3.7	0		10	-1	=	-1
14	4	6	2.9	1					
15	5	3	4.7	0					
16	5	4	3.7	0					
17	5	7	4.7	0		Total Distance	13.4		
18	5	8	4.6	0					
19	6	4	2.9	0					
20	6	8	2.4	1					
21	6	9	2.5	0					
22	7	5	4.7	0					
23	7	8	1.2	0					
24	7	10	3.2	0					
25	8	5	4.6	0					
26	8	6	2.4	0					
27	8	7	1.2	0					
28	8	10	2.1	1					
29	9	6	2.5	0					
30	9	10	2.5	0					
31	10	7	3.2	0					
32	10	9	2.5	0					

TABLE 2: Potential Links for Shortest Path Model.

	H
3	NetFlow
4	SUMIF(\$B\$4:\$B\$32,G4,\$E\$4:\$E\$32)-SUMIF(\$C\$4:\$C\$32,G4,\$E\$4:\$E\$32)
5	SUMIF(\$B\$5:\$B\$32,G5,\$E\$5:\$E\$32)-SUMIF(\$C\$5:\$C\$32,G5,\$E\$5:\$E\$32)
6	SUMIF(\$B\$6:\$B\$32,G6,\$E\$6:\$E\$32)-SUMIF(\$C\$6:\$C\$32,G6,\$E\$6:\$E\$32)
7	SUMIF(\$B\$7:\$B\$32,G7,\$E\$7:\$E\$32)-SUMIF(\$C\$7:\$C\$32,G7,\$E\$7:\$E\$32)
8	SUMIF(\$B\$8:\$B\$32,G8,\$E\$8:\$E\$32)-SUMIF(\$C\$8:\$C\$32,G8,\$E\$8:\$E\$32)
9	SUMIF(\$B\$9:\$B\$32,G9,\$E\$9:\$E\$32)-SUMIF(\$C\$9:\$C\$32,G9,\$E\$9:\$E\$32)
10	SUMIF(\$B\$10:\$B\$32,G10,\$E\$10:\$E\$32)-SUMIF(\$C\$10:\$C\$32,G10,\$E\$10:\$E\$32)
11	SUMIF(\$B\$11:\$B\$32,G11,\$E\$11:\$E\$32)-SUMIF(\$C\$11:\$C\$32,G11,\$E\$11:\$E\$32)
12	SUMIF(\$B\$12:\$B\$32,G12,\$E\$12:\$E\$32)-SUMIF(\$C\$12:\$C\$32,G12,\$E\$12:\$E\$32)
13	SUMIF(\$B\$13:\$B\$32,G13,\$E\$13:\$E\$32)-SUMIF(\$C\$13:\$C\$32,G13,\$E\$13:\$E\$32)
14	SUMIF(\$B\$14:\$B\$32,G14,\$E\$14:\$E\$32)-SUMIF(\$C\$14:\$C\$32,G14,\$E\$14:\$E\$32)

TABLE 3: SUMIF formula to calculate the NetFlow.

	G	H
17	Total Distance	SUMPRODUCT(D4:D32,E4:E32)

TABLE 4: SUMPRODUCT formula to calculate the Total Distance.

Once all the data is updated on excel, the analytical solver function to optimize the data helped find the shortest path. The Solver parameters would be to set the objective cell to “Total Distance”, by changing the variable cells “On Route” which are subjected to a constraint of “NetFlow” being equal to the “Supply/Demand”. The variables would be non-negative, and the solving method is simplex LP (Figure 6). Once the optimized result is obtained, the shortest path is represented by highlighting the links of the path on the network graph. (Figure 8) The shortest route has a total distance of 13.4 miles.

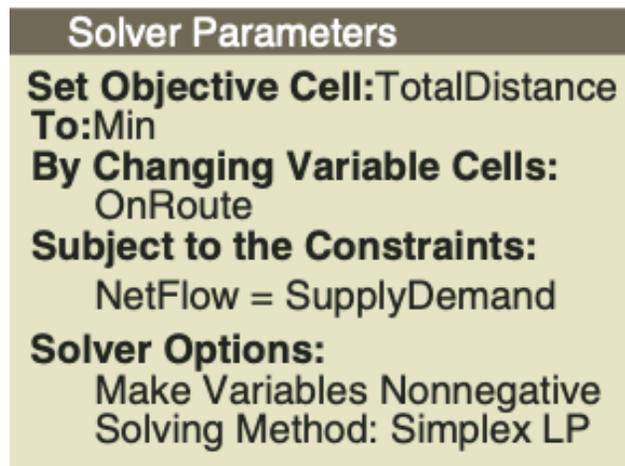


FIGURE 6: Solver Parameters for Shortest Path.

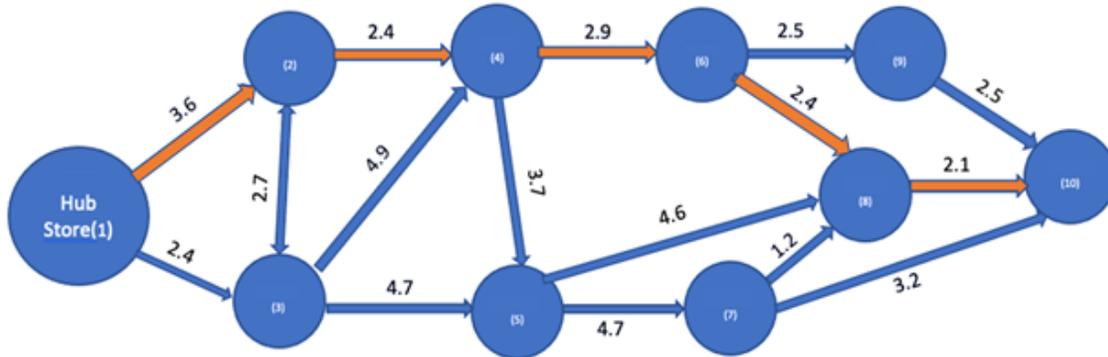


FIGURE 7: Shortest Path Model.

The route provides the least distance to reach the last store in the network but has failed to connect all the nodes in the network. Thus, this model does not fit the constraint model.

4.9. Minimum Spanning Tree Model

This model is very similar to the shortest path model; in both the model an undirected and connected network is utilized. In a minimum spanning tree model, the required property is that the chosen path should provide a path between each pair of nodes. With the potential links between each node, it is possible to design the network by having the minimum number of links that have a path between every pair of nodes. If there are N nodes present in a network, there should be only $N-1$ links present in the network to satisfy the model's condition. This model is easy to be put into practice as this is one of the few models where being greedy at every iteration can still give an optimal solution for the network. The process is simple, identify a node where the path is desired to begin from. In this case, it is the Hub Store. Once identified connect this node to the nearest distinct node. Once connected, identify the closest unconnected node to this distinct node. Connect these two nodes and repeat the iteration until all nodes (N) relate to $(N-1)$ links. Table 8.4 shows all the potential paths for the network and the highlighted columns show the minimum spanning tree links for the network.

From	To	Distance	On Route
1	2	3.6	●
1	3	2.4	●
2	3	2.7	●
2	4	2.4	●
3	4	4.9	●
3	5	4.7	●
4	5	3.7	●
4	6	2.9	●
5	7	4.7	●
5	8	4.6	●
6	8	2.4	●
6	9	2.5	●
7	8	1.2	●
7	10	3.2	●
8	10	2.1	●
9	10	2.5	●
Total Distance		22.3	

TABLE 4: Potential Links for Minimum Spanning Tree Model.

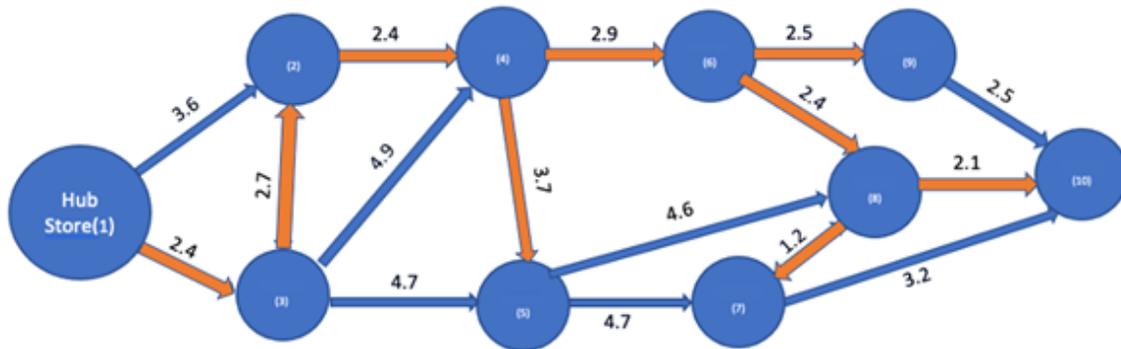


FIGURE 8: Minimum Spanning Tree Model.

The minimum spanning tree model gives a total distance of 22.3 miles for the network. The highlighted path in the figure shows the critical path for the network. This model connects all the nodes of the network and ensures reaching the last node of the network but takes a longer distance to cover all the nodes. This model would have been effective if only trying to establish a critical network path. As the path is not continuous the shuttle can revisit a node within the network more than once which means it would involve more distance and operation cost than what has been estimated above.

4.10. Traveling Salesman Model

There are close parallels to a minimum spanning tree and a traveling salesman problem (TSP). Each of these models is presented with all the potential links in the network and in both the models, the links need to be chosen to create an optimal path. The objective of the model to

minimize the total distance traveled. For a traveling salesman problem, it is needed to find the distance of every single node to every other node in the network. Table 8.5 represents the distance matrix for each node in this network. The objective here is to make sure that start begins from the HUB node and returns to the HUB node by covering all the other nodes at the end of the iteration. Once the matrix is created, nodes are arranged as a random sequence in excel. Now to find the distance between each node in the sequence this has been arranged using the index function. Once the distance between each node is found according to the sequence, summation of all the distances and that will give the total distance of the network for a random sequence. To find the best sequence optimization of the model is determined using the excel solver. (Figure 9) The set objective is to minimize the total distance of the sequence by varying the random sequence that have been created for the network. As the shuttle service is needed to visit every node only once, constraining the sequence model to be different after each iteration was completed. The solving method being used would be the evolutionary method rather than the simplex LP model. As the total distance for a random sequence model the evolutionary model will try to find a better solution than the existing solution. Once the model finds an optimized solution closer to the initial solution it will try to find a better solution than the second optimized solution to figure out the best-optimized solution after several iterations.

Store No.	HUB	2	3	4	5	6	7	8	9	10
HUB	-	3.6	2.4	5.7	5.2	8.6	9.9	10.2	11.1	12.2
2	3.6	-	2.7	2.2	4.7	5.2	8	7	7.6	9.1
3	2.4	2.7	-	4.9	4.7	7.8	9.4	9.7	10.2	11.7
4	5.7	2.2	4.9	-	3.6	2.9	5.3	4.7	5.4	6.7
5	5.2	4.7	4.7	3.6	-	4.8	4.7	4.6	7.3	6.7
6	8.6	5.2	7.8	2.9	4.8	-	4.5	2.3	2.5	3.9
7	9.9	8	9.4	5.3	4.7	4.5	-	1.2	5.5	3.2
8	10.2	7	9.7	4.7	4.6	2.3	1.2	-	4.4	2.1
9	11.1	7.6	10.2	5.4	7.3	2.5	5.5	4.4	-	2.5
10	12.2	9.1	11.7	6.7	6.7	3.9	3.2	2.1	2.5	-

TABLE 5: Distance Matrix .

Solver Parameters

Set Objective Cell: Total Distance

To: Min

By Changing Variable Cell:
Sequence

Subject to the Constraints:
Sequence = Diff

Solver Options:
Make variables Nonnegative
Solving Method: Evolutionary

FIGURE 9: Solver Parameters for Travelling Salesman Model.

Sequence	1	2	4	6	7	10	9	8	5	3	1
Distance	3.6	2.2	2.9	4.5	3.2	2.5	4.4	4.6	4.7	2.4	
Total Distance	30.6										

TABLE 6: Optimized Travelling Salesman Model.

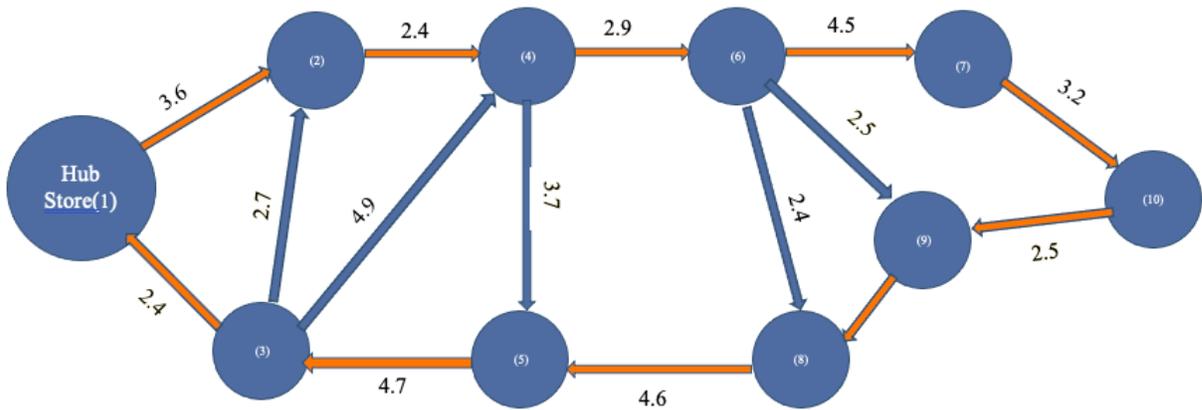


FIGURE 10: Traveling Salesman Model.

The Travelling salesman model gives a total distance of 30.6 miles for the network. The highlighted path shows the best optimal route for the transportation of the vaccination. This model gave us the shortest distance, that adhered to all the constraints of the model. The travelling salesman model will ensure that the delivery of the vaccination will not get disrupted to any of the stores as it follows a cyclic route and ensures all the nodes in the district are covered in a single routing plan. Even if a single store is affected by any kind of disruption the vaccination shuttle can continue its route to the next store and deliver the excess vaccination to that store. This can ensure that the people effected with the closure of the store can still go to the nearest store from the affected area and can still get vaccinated which can help prevent a chaotic environment in the community. This model is not only efficient in preventing disruption of the supply chain but is also economically viable to the organization. The model has the least complication involved with route planning and has the shortest distance with respect to a time constrained model.

5. CONCLUSION

The framework presented in this paper takes into consideration the disruption of the supply chain by considering the interdependency between the supply chain network model and the infrastructure of the organization. If any of the nodes apart from the root node fails in this network the failure would be considered as a non-cascading failure. The node that fails in the network will have a very small impact on the overall network. To prevent this kind of failure it is important to harden all the nodes and links in the network which would be expensive. If the root node (HUB) is infected or destroyed in this model then the resulting failure would be a cascading failure, as the failure of this single node can have a larger impact on the entire network. This would be the worst-case scenario as cascading networks would destroy the entire network system and prevention of a cascading failure would be expensive. The goal of this study was to provide an efficient resilient strategy for real life situations. Zhan et. Al (2017) methodology was just a simulation of a real-world problem using computational algorithms, it failed to take into consideration the human element which is considered as a major limitation. Similarly, Gupta et al. (2002) and Brown et al, (2001) study was focused on the supply chain aspect from the supplier plant to the distribution centers but failed to emphasize the need to strengthen the nodes closer to the end consumer, to prevent any kind of disruption in the supply chain network. The travelling salesman model fits this strategy by ensuring all the objectives of the network is accomplished. The use of the optimal route can also reduce the operation cost and reduce the vulnerability

faced during these unprecedented times. This is a first of a kind of a study conducted for this organization. However, there exists some limitation to our research, which are also a direction for future research.

During the research study there were a few limitations to the study that were identified. As the study was confined to only one of the districts of the pharmaceutical store, the study was not able to identify the potentials of working with other districts within the area. The company having nearly 10,000 stores nationwide it was difficult to obtain the data for each district and conduct the analysis. Therefore, the critical nodes in an event of a cascading failure can be supported from Hubs that are present within the same area but different districts. This limitation was identified however was not pursued due to time constraint and the lack of data for the entire organization. These limitations can be considered for future research and can be used to help understand the models used in this study from an organization perspective to implement the analysis of the work done during the research. With Covid -19 vaccinations being a major priority across the United States and with no affordable strategy for the protection of the stores throughout the country this study acts as a building block, emphasizing the necessity of identifying critical nodes within a network. The cost involved in hardening or protecting all the stores in the district is not practical, therefore we identified the critical nodes in the network. Protection of these specific stores is the most practical solution to the problem.

As per this study, classification of the network as a random network was determined. But random networks have a lot of limitations concerning critical infrastructure. This study should be used as a foundation to convert the network into a structured network (scale-free, small world, Pareto, etc.). Where protection of a few critical nodes could minimize the cascading effects on the network, it could help to ensure the safety and well-being of the surrounding community. According to an experimental study, a random network whose nodes get randomly infected has a 99% chance of failure on average whereas a scale-free network with a protected hub has only 66% chances of average failure. The survivability rate of the scale-free network is much more optimal when compared to that of the random network. The efficacy of a critical node analysis has still not been proved, as their application to real-world situations is limited. This case study in the middle of the pandemic year will act as a research analysis tool to prove the importance of the analysis of the critical nodes in a network model for essential service organizations.

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INSTRUCTIONS TO CONTRIBUTORS

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