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Building Resilience for Supply Chains

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INTRODUCTION

We are delighted to welcome our friends and colleagues, both old and new, to the 25th International Symposium on Logistics albeit virtually. Normally, the ISL provides a forum and an opportunity to meet and network in an informal setting. However, as everyone is aware that the ISL 2020 which was due to be held in Seoul, Korea had to be cancelled due to the COVID-19 pandemic. The organising committee debated and agonised over the last 12-15 months or so on how to continue with our annual event. After extensive consultations, discussions and deliberations it was decided to hold the entire ISL 2021 online, deploying Microsoft Teams as a platform.

Bearing this in mind, two categories of paper submissions were invited. The first type were so called 'Full Papers' - that is up to 8 pages in length along with a one-page structured abstract. These types of papers were subject to a peer review process. These papers, if accepted, are included in the part 2 of the Proceedings of the Conference with an ISBN number. The second category of papers that were invited were labelled as 'Working Papers'. These may be considered as developmental, representing early-stage research ideas or initial findings. Only the abstract was required for the initial submission, which underwent the review process. If accepted, the authors were required to submit an expanded (between 4-6 pages) version of the abstract. These Working Papers were made available on the ISL website for a limited period so that the registered delegates could access these during the event. However, only the abstracts of the working papers appear in this set of proceedings in part 1. It is expected that the submitted Working Papers would be significantly changed for any subsequent journal publication. Both types of paper submissions – working papers and full papers – were considered for publication in the special issue of the International Journal of Logistics Management or Computers and Industrial Engineering. All submitted papers were invited for a 10-minute presentation during the two-day event.

Considering the high degree of volatility and uncertainty brought by the COVID-19 pandemic, this year's theme was chosen as '*Building Resilience for Supply Chains'*. Despite this event being online, nonetheless, the 25th ISL in essence aimed to provide a forum for both academics and practitioners to discuss the current and future research in the area of logistics and supply chain management. The papers in this book proceedings represent the latest in academic thinking, as well as case examples of successful implementations. The 25th ISL, also presents an opportunity to engage in various discussions and debates during the course of the event, exploring how our models, concepts and findings are pushing the frontiers of knowledge in the area of logistics and supply chain. Equally, it is important to explore how our cumulative know-how in our discipline can be successfully applied to develop the next generation of experts through our teaching and curriculum development as well as helping the practitioner community to enhance the competitiveness of industry.

For us as event organisers, it has been a huge learning experience as we had to grapple with the uncertainties associated online platforms, its accessibilities and reliability for all the participants and above all trying to accommodate the presentations bearing in mind the constraints of different time zones. However, we are delighted with the success in terms of number of submissions resulting in 65 paper presentations representing authors from over 30 countries. In addition to this, we were fortunate to have four excellent keynote speakers namely, Prof Neil Ashworth, UK; Prof Christopher Tang, USA; Prof Roya Javadpour, USA and Mrs Usha Padhee, India. We were also pleased to host a journal publishing workshop with experienced editors at hand to provide guidance on do's and don'ts. Our colleagues in Korea also organised an online workshop entitled: *'COVID 19 and logistics from the Asian perspectives'*, with presentations from UPS Korea, Hyundai Motors and Hyundai Merchant Marine.

On the whole the event proved to be highly successful considering the variety of activities ranging from keynotes, paper presentations, workshops, debates etc. These were further

supported by a user-friendly online virtual group video chat tool which allowed for informal chat amongst the delegates. All these activities enabled the ISL community to maintain its tradition as an informal yet productive and knowledge intensive event – all in all culminating in another memorable experience and successful event, despite the pandemic.

As mentioned above, like in previous years, all abstracts and/or full papers were reviewed by two or more academic experts from the field of Logistics and Supply Chain Management. This book of proceedings containing the accepted papers, has been organised in 2 parts according to the following categories:

Part I: Abstracts
- Smart Logistics and Supply Chains
- Global Supply Chain, Complexity and Management
- Logistics Network Design, Analytics and Management
- Building Supply Chain Resilience
- Sustainability
- Transportation, Distribution and Humanitarian Logistics

Part II: Full Papers
- Smart Logistics and Supply Chains
- Transportation, Distribution and Humanitarian Logistics
- Supply Chain Complexity and Resilience

To date ISL has been held in Europe, Africa, Australia and Asia (see full list below), and the last event was held in the historic and beautiful city of Würzburg, Germany. Following cancellation of ISL in 2020 due to the pandemic, this year's event was an online affair and a totally new experience for us all.

Last but not least we would like to take this opportunity to express our sincere thanks to all the presenters, delegates, reviewers, Advisory Committee members, organising team, invited guest speakers, partner journals - International Journal of Logistics Management (IJLM) and Computer in Engineering Computers and Industrial Engineering (CAIE) for their valuable support and contributions. Finally, our special thanks go to Mrs Amita Sudhakar and Dr Jasper Donelan for their advice and unwavering support before and during the event making sure the online technology worked to perfection.

Professor Kulwant S Pawar, Dr Andrew Potter, and Ajeseun Jimo – July 2021.

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SECTION 1 – SMART LOGISTICS AND SUPPLY CHAINS

Smart Logistics as a Digital Ecosystem: An Integrative Literature Review and Conceptual Framework

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University of Applied Sciences Würzburg-Schweinfurt, Germany

Purpose of this paper:

Smart logistics is a popular topic these days, connecting logistics to the overarching trend of the "smart factory" or "Industry 4.0". However, despite its attractiveness and suggested practical value, it seems to be still (1) limited to isolated applications in industry and (2) insufficiently conceptualized in academic research. The purpose of this paper is to develop a consistent conceptual framework for smart logistics that can be used to design integrated smart logistics solutions.

Design/methodology/approach:

Applying the theory lens of the digital ecosystem, we use an integrative literature review to identify and put into a consistent perspective the various conceptual elements of smart logistics suggested in extant research. We analyze these elements along three dimensions according to the main categories of digital ecosystems: (1) digital species (the smart objects in logistics), (2) space (the processes in which these smart objects are relevant), and (3) domain (the objectives these smart objects pursue). We classify the smart objects as intelligent products, while for the process dimension we make use of the building blocks (production, storage, and transportation) of the self-similar architecture of supply chains. The categories for the objective dimension are synthesized from the papers selected for the integrative literature review.

Findings:

The published research on smart logistics has already produced a set of smart objects in logistics. However, our analysis reveals that – beyond a common ground with respect to the underlying ubiquitous technologies of smart logistics – the conceptualization of the objects' smartness, i.e. which objectives they autonomously pursue, is much less consistent. Our study shows that digital ecosystems are a promising approach to a consistent conceptualization of smart logistics.

Value:

Few papers systematically analyze the extant research on smart logistics, but they are either limited to a small subset of the supply chain, the underlying ubiquitous technologies or discuss a specific focus like the contribution of smart logistics to fulfilling individualized customer demands. To the best of our knowledge, our study is the first to integrate the extant literature into a consistent conceptual framework for smart logistics.

Research limitations/implications:

The conceptual framework still needs to be validated through discussions with industry experts and case studies.

A framework for logistics platform service ecosystem: empirical evidence from logistics sectors in China

Li Qing[1], Nicky Shaw[2]

[1]Shanghai Business School, China, People's Republic of; [2]Leeds University Business School

Purpose of this paper:

Given the emergence of logistics service-oriented platforms in China, high demand for efficient logistics service has driven platform enterprises to establish ecosystem. However, the current literature has not provided sufficient study on platform service supply and how to establish platform ecosystem in the logistics sector. The paper proposes the typology of logistics platform and features of logistics platform service, and then illustrate the mechanism from platform service supply chain to platform service ecosystem. The paper aims to present the structural element of the platform service ecosystem, and to explore the mechanism that support the sustainability of platform enterprises and its ecosystem. The paper also looks into the driving force of digital transformation of both logistics platform enterprise, its complementors and users to build a sustainable platform ecosystem.

Design/methodology/approach:

Based on an exploratory multiple-case study, the paper investigates four logistics platform enterprises who are at different phase of establishing their own ecosystem. They are involved in four specific logistics service-oriented activities: fourth-party logistics service, logistics park service, logistics cloud service and non-truck operating common carrier service. They gain sustainable success and reputation.

To analyze the cases, we iteratively collected primary and secondary data from four companies and followed procedures of the grounded theory methodology. For gathering primary data, we conducted semi-structured interviews with managers. In addition, we evaluated available documentation as secondary data.

Findings:

The findings include the structure of the platform service supply chain, platform service ecosystem, the features of platform services in logistics sector, and the mechanism from platform service supply chain to platform service ecosystem, the digitalization and collaboration in the platform service ecosystem, and a proposed sustainable framework of the platform service ecosystem.

This research develops a five layer structural network for the sustainable platform service ecosystem. The driving forces of platform service ecosystem include resource integration, inter-organizational collaboration, platform interaction, value co-creation and technology-driven service innovation with the background of digital transformation.

Value:

The research results are believed to contribute to the area of service supply chain management and platform ecosystem via proposing a structural mapping of the platform service supply chain and

developing a framework of sustainable platform service ecosystem. The research is also expected to contribute to the area of platform governance strategy through bringing platform and ecosystem together.

Research implications:

The research findings contributes to previous business ecosystem and platform literature and take a more integrative and holistic approach to the exploration of platform service chain and reveal the facilitation from platform service chain to platform ecosystem.

Practical implications:

China has a unique context of boosting logistics platform developments in recent years. Empirical findings of China shed light on other countries' platform enterprise developments. The research helps logistics platform enterprises design their platform service business models and construct platform service ecosystem when necessary. Future research may involve the exploration of sustainable platform ecosystem design processes and ecosystem innovation from cross-disciplinary perspective. It also provides practitioners with managerial and practical insights to guide them in building a successful platform service supply chain and management strategies.

Sustainable Development of Digital Platforms: A Systematic Literature Review and Future Directions

Shuang Tian, Lin Wu, Kulwant S. Pawar
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Purpose:

Existing literature on digital platforms* lacks an integrated view of inter-disciplinary perspectives on the platform's sustainable development. The research presented in this paper aims to review the literature related to the development of digital platforms in the past ten years, discuss the up-to-date research and research gaps in this field, and present future research directions. The overall aim of the study is to review the literature related to the sustainable development of digital platforms in the past ten years, discuses the up-to-date research and research gaps in this field, and present future research directions.

Design:

This research adopts a systematic literature review method to collate and summarize relevant published papers (187) over a time span of ten years (2010- 2020), and categorizes them into ten industries based on different application areas of digital platforms.

Findings:

Ten industries where digital platforms have been applied are identified in our study: sharing economy, social media platform, labour platform, healthcare platform, third-party payment, crowdfunding platform, lending platform, electronic business platform, tourism platform, food platform. As one would expect, due to the diversity of industrial sectors', the research and developments of platform in various industries exhibits different characteristics and trends. For example, the sharing economy platform's research focuses on the business model and dynamic capabilities, platform transformation, user motivation, and user loyalty based on trust theory and other topics. Besides, the social media platform's research directions include the online media platform ecosystem, knowledge dissemination theory, and consumer analysis. Future research directions include further improving platform business model innovation, platform transformation, protecting platform participants' rights, improving consumer confidence, and reducing market risks, exploring the platform's impact from the three sustainability perspectives: economic, society, and environment. Besides, exploring the platform ecosystem's supply chain resilience to improve platform members' ability to resist risks is also an essential research direction.

Value:

To our best knowledge, this research is the first attempt to systematically review the development and deployment of platform in different sectors and their potential impact on sustainability. By expounding the main themes and viewpoints of platform sustainability research, this research maps and presents the status quo of the existing body of literature, identifies research gaps, and provides potential future research opportunities for platform sustainable development innovations and practices.

Research implications:

Firstly, this research study spans across interdisciplinary boundaries that brings together academic research on the digital platform's sustainable development in different industries. Secondly, it discusses the opportunities and challenges of the digital platform companies and their ecosystems through systematic literature review and content analysis. Thirdly, this research proposes future research directions for different industries from three sustainable perspectives.

Practical implications:

Platform companies and platform-related ecosystem members are developing rapidly and the development is expected to further strengthen in the future. This research reveals the sustainability issues that platform companies may face through a comprehensive analysis from the three sustainability perspectives. In terms of social sustainability within the extended supply chain context, platform providers may need to consider issues such as staff benefit, safety and improve on fringe benefits for staff retention etc. To improve environmental sustainability, the platform companies can help to reduce waste and promote resource recycling through enterprise cooperation. Regarding economic sustainability, improving supply chain resilience and customer loyalty can enhance platform companies' ability to respond to risks.

*The digital platform is defined as an expansible codebase based on program systems provides a shared module that interoperates with software systems and an interactive interface (Tiwana et al. 2010).

References:

Tiwana, A., Konsynski, B., & Bush, A. A. (2010). Research commentary—Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. Information systems research, 21(4), 675-687.

THE IMPACT OF BLOCK CHAIN TECHNOLOGY ON THE FINANCIAL ECOSYSTEM: A PROPOSED RESEARCH AGENDA

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Arab Academy for Science, Technology and Maritime Transport (College of International Transport and Logistics)

Purpose of this paper:
The financial industry is witnessing continuous evolving and adoption of new technologies such as Fintech that has been embedded in the financial system for years (Ozili, 2018). One of the currently most promising technologies that is beginning to get attention and be implemented in the financial industry and Supply Chain practices is the block chain technology (BC) (Harris and Wonglimpiyarat, 2019; Tran and Nguyen, 2021). This research aims at illustrating the relationship between BC technology utilization and the financial ecosystem and concluding with proposed research agenda in this area.

Design/methodology/approach:
A generic review is conducted to provide more insights on new trends in the financial ecosystem and application of BC technology in the financial ecosystem. The generic literature review is done by gathering studies from the year 2008 till 2021 and from reliable databases. Based on it research aims are fulfilled where the relationship between BC and financial ecosystem is illustrated and research gaps in this area are identified.

Findings:
By investigating the available literature and research in this topic, several research gaps were revealed. Some of which had been addressed such as the conceptual relationships between technology and financial ecosystems. Also, the relationship between BC and the financial ecosystem is illustrated and confirmed by analysing the results of some chosen studies according to the research methodology.

Value:
Most of the available studies on BC technology focuses more on the technical side of its application. However, this study contributes to knowledge by focusing on the non-technical implications of employing the technology in the financial industry. This study also provides practitioners with insights on how BC technology can be implemented in the financial ecosystem.

A simulation model for evaluating the efficiency of robot-supported order picking warehouses

Minqi Zhang[1], Sven Winkelhaus[2], Eric H. Grosse[3], Christoph H. Glock[4]

[1]Saarland University, Germany; [2]Technical University of Darmstadt, Germany; [3]Saarland University, Germany; [4]Technical University of Darmstadt, Germany

Purpose

Order picking is often performed manually by humans in so-called person-to-goods systems, which is still most prevalent in practice (de Koster et al. 2007, Grosse et al. 2015, 2017). Order picking requires a high amount of manual work, making it a very time- and cost-intensive process step in warehousing (Grosse et al. 2017). In recent years, efforts have been made in research and industry to develop technical systems to automate or support manual order picking tasks, for example the travelling step, with the intention to reduce costs and improve productivity (Boysen et al. 2019; Glock et al. 2020). Examples include automated guided vehicles or mobile robot fulfilment systems (Azadeh et al. 2019; Winkelhaus and Grosse 2020). Although there are some interesting use cases in practice (Magazino 2020), autonomous picking robots, which can substitute humans in a person-to-goods system, have not received much attention yet (Fragapane et al. 2021). The aim of this paper therefore is to evaluate the cost benefits of employing such autonomous picking robots that collaborate with humans in order picking compared to (purely) manually operated warehouses.

Design/methodology/approach

The paper first proposes a concept for collaborative order picking between humans and autonomous picking robots. Following, an agent-based simulation model is developed and then implemented in the software Plant Simulation by Siemens PLM Software. The simulation model allows varying warehouse design and order picking process parameters as well as the number of human and robot pickers and their characteristics. The model also considers blocking situations between humans and robots. As the main performance measure, the number of items picked in completed orders per shift (throughput) is counted and allows a comprehensive cost analysis. This structured simulation study helps to gain insights into how robots and humans interact in collaborative order picking and how their characteristics as well as the parameters of the warehouse, collectively, influence warehouse operating costs.

Findings

Preliminary results indicate that collaborative order picking between humans and autonomous robots has a great potential to reduce operating costs in warehouses compared to conventional manual order picking. The absolute savings, however, strongly depend on the parameters of the simulation model. The way workload is shared between humans and robots as well as zoning and routing decisions impact blocking situations and have a considerable effect on throughput. In addition, the results of the simulation model are sensitive to the operating and cost parameters assumed for the robots. As robots can still mostly only be employed for standardized goods, higher costs for prepacking and inventory holding can be assumed, which increases the profitability of collaborative picking scenarios compared to only manual or only robot order picking. The proposed model supports evaluating these interactions.

Value

This paper is among the first to evaluate the cost reduction potential of collaborative order picking in warehousing using a comprehensive simulation model. It evaluates different configurations and characteristics of manual and robot order picking systems and thus supports a (gradual) shift from traditional manual order picking in warehouses to increased use of autonomous technology in practice.

Limitations

The proposed model could be extended to include further warehouse layouts and order picking strategies currently not covered in the model implementation. In addition, benefits of collaborative order picking systems that extend beyond reductions in costs, such as improved ergonomics and job satisfaction for human operators, need to be considered in addition to fully evaluate the potential autonomous picking robots may offer in a warehousing context.

The results of the paper support companies in operating such systems, as well as when deciding on whether or not collaborative order picking systems employing autonomous robots that collaborate with humans should be implemented.

Warehouse Automation: A barrier or opportunity to make supply chains more resilient?

Steve Pospisil[1], Andrew Lahy[2], Pauline Found[3]

[1]Logistics Education Centre, United Kingdom; [2]University of Buckingham, United Kingdom; [3]Cardiff University, United Kingdom

PURPOSE OF THE PAPER

Warehouses play a critical role in supply chains, constitute a major cost (Baker and Halim 2007) and can play a significant role in either enabling supply chain resilience or hindering it. In terms of achieving supply chain resilience, maintaining flexibility is a key requirement (Ali, Mahfouz, and Arisha 2017). On one hand, warehouse automation can be considered a barrier to such flexibility (Wiktorsson et al. 2016) but on the other hand, warehouse automation offers a major opportunity to increase efficiencies and significantly reduce costs.

This paper seeks firstly to investigate the current barriers to and opportunities of automation in warehousing. In particular, the research seeks to understand if recent major market changes, such as the impact of CV-19, increased barriers to global trade (such as Brexit) and newly available automation technologies have changed the view of firms towards adopting warehouse automation. Secondly, the paper seeks to assess whether warehouse automation can help companies make their supply chains more resilient, or conversely by reducing flexibility, warehouse automation makes supply chains less robust.

RESEARCH METHODOLOGY

This paper aims to bring together industry insight with existing literature to understand the current barriers and challenges of the use of warehouse automation.

The paper makes use of force field theory (Lewin 1951; Burnes and Cooke 2013; Swanson and Creed 2014) to understand the driving and constraining forces of firms making use of automation. A range of industry experts were interviewed to understand the current driving and constraining forces of using automation. We first asked them for their view on what defined supply chain resilience and whether they considered this was increasingly or less important today than five years ago. Following this, we then asked whether it is considered that warehouse automation enables or constrains supply chain resilience. Finally, we asked what are considered to be the key driving and constraining forces of firms making use of warehouse automation in the future?

FINDINGS

We concentrate our attention on automation in warehousing as warehousing plays a critical role in supply chains and also constitutes a major cost (Baker and Halim 2007). The data will be presented using a force field analysis technique to understand the strength of the barriers and driving forces identified.

VALUE AND ORIGINALITY

This paper brings together industry insight and seeks to bring clarity to the term resilience in the context of warehousing. It also seeks to increase understanding of the driving forces and barriers to firms adapting warehouse automation to allow researchers and practitioners to understand, in particular, the barriers that may need to be overcome if warehouse automation becomes a supply chain necessity of the future.

RESEARCH LIMITATIONS

Only a limited number of industry experts are interviewed, but although limited, detailed and rich data were captured and analysed.

PRACTICAL IMPLICATIONS

The uptake of warehouse automation has a major impact on both supply chain costs, flexibility and resilience. For supply chain companies who want to increase resilience, a key question is whether automation supports or hinders such a move. This research will shed new light on this question. Moreover, for many firms, recent major market changes may increase or decrease their reluctance to adopt warehouse automation. This research will allow firms to understand better the driving and restraining forces for adopting automation techniques in warehousing and for those that do want to adopt warehouse automation, the barriers to be overcome.

An Assessment of Warehouse Management Practices: The case of Tuticorin, Tamil Nadu

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Purpose of this paper:
The main aim of this paper is to describe the current status of warehouse management practices in Tuticorin, Tamil Nadu (TN), India.

Design / Methodology / Approach:
A detailed descriptive analysis was made from the 55 registered companies of Direct General Foreign Trade (DGFT) that were taken for the study. In this context, the present study is experimental in nature and data were collected through structured formal interviews followed by filling the questionnaire by the respondents. The questionnaire was developed by taking into consideration factors like demographic variables like age, gender, designation. Parameters like categories of goods, equipment, infrastructure, security features, material tracking methods, importance of time indicators, and major challenges were explored while considering reviewing different categories.

Findings:
Our analysis was found that most of the warehouse companies in Tuticorin, TN, India are unorganized and fragmented due to a lack of skilled workforce, technology update, and inefficient multi and intermodal transportation. Automation implementation in entire warehouse operations must require to tackle certain obstacles such as mishandled raw materials and irregular inventory. Care should be taken from both the government and industry bodies to come up with a new idea to improve the infrastructure parameters to meet the global demand.

Value:
This paper provides a benchmark for organizations assessing the quality of their warehouse management practices and helps identify opportunities for significant improvement. Also, the study can be of use to warehouse operations to strengthen their existing warehouse management practices framework and need to compete with global standards.

Research limitation / Implications:
There are great opportunities for warehouse management practices and improvement within firms and across the supply chain management in Tuticorin, TN, India. Firms can and should collaborate with the Government of India and the State Government to implement appropriate measures of warehouse management practices in Tuticorin, TN, India.
The research study has limited only on warehouse companies in Tuticorin, TN, India and further research should extend to remaining major ports of India.

Game-based Learning in Supply Chain Management: Influences of study programs and cultural differences on learning outcomes

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Purpose of this paper:

Complexity of supply networks challenge competence development in traditional learning environments. Game-based learning (GBL) allows for learning environments that facilitate the learning process through experiences and feedback. Games are used in different subjects of higher education including Supply Chain Management (SCM) [1].

In previous work [2], we have discussed how a freely available on-line game can be embedded in different SCM courses offered Engineering and Business students at European Universities with different teaching traditions. These findings inspired us to investigate in more detail how not only the students and teachers experience experimental teaching methods, but also cultural and domain-specific knowledge influences the engagement and learning outcome of the students.

Design/methodology/approach:

Experiences in playing Shortfall, a SCM serious game, with students from international universities encouraged a closer analysis of outcomes and differences. Three groups of industrial engineering students have been analysed, one group from Sweden, one from Germany and one from Chile. The Chilean study group was more aware of primary raw material supply chains while the Swedish and the Germans were both very familiar with the automotive supply chain as well as the different technologies. All three groups played Shortfall in a similar setting with briefing, experience (playing) and debriefing sessions. However, the student groups had different levels of experience with GBL courses. Questionnaires and observational data were used to compare outcomes. In addition, information on the study programs and the broader educational environments were considered for the analysis. Data was collected and analysed per study group and then compared to identify differences and commonalities between the groups.

Findings:

Both the level of experience with GBL and domain-specific knowledge on automotive supply chains are crucial for the learning outcome. Facilitators should consider the domain-specific knowledge needed by their students to adopt to the game environment. Furthermore, it is important to extend the introduction phase for groups of students not familiar with experiential learning to increase the learning outcome; not only to familiarize the students with the game environment and user interface, but primarily to convey the method of experiential learning and nurture the constructive thinking process.

Value:

The work contributes to a better understanding of challenges as well as opportunities when using serious games in SCM education where students have different levels of experience with GBL and different domain-specific knowledge. Lecturers in higher education may utilize the findings to adjust their course settings

Research limitations/implications (if applicable):

The study was limited to three groups of industrial engineering students from distinct study programs. Future research may also consider student groups from business management with a major in SCM to broaden the understanding of influences due to study backgrounds.

Practical implications (if applicable):

To address limited experience with GBL, study program design may adopt course modules in general. To compensate for limited domain-specific knowledge, facilitators should review their course design regarding the briefing phase and continuous supervision during game play.

ENHANCING SUPPLY CHAIN INFORMATION SHARING WITH THIRD PARTY LOGISTICS SERVICE PROVIDERS

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Purpose of this paper:
This study evaluated the enhancement of information sharing practices with Third Party Logistics service providers (3PLs) in a supply chain solutions company that provides transport and warehousing software in Johannesburg, South Africa. The visibility of information has been a challenge for 3PLs who exist within South African supply chains (Bothma, Pillay, Rolle & Singh, 2014). Various studies have found that the complexity of dealing with too many networks (Cheng, Chen and Chen, 2014) ultimately leads organisations with limited levels of information to suffer inefficiencies related to growth in inventory levels, higher costs, ineffective communication and counter-productive relationships (Costantino, Gravo, Shaban & Tronci, 2013).

Design/methodology/approach:
A mixed methods case study was conducted to investigate the problem. Three rounds of primary data were sequentially collected, analysed and triangulated. An online questionnaire was distributed to a sampling frame of seventeen companies who were randomly selected from the population. A focus group interview was prepared for Dovetail executives who were purposively sampled to participate in the interview. The third round included the distribution of an open-ended questionnaire to explain and validate the findings from clients and executives who participated in the two rounds of data collection.

Findings:
Findings discovered that sharing information improves the collaboration of channel members, increases competitive advantage and ultimately leads to better customer service. They further revealed that lead times, unsynchronised technological infrastructure and a lack of commitment were a challenge at the solutions company. The improvement of relationships and continuous technological upgrades were recommended for improving visibility of information and effectiveness in the management of supply chains.

Value:
The value of the study contributes to the supply chain's dependence on 3PLs for value creation and the reliance on technology to share information amongst channel members. This study highlights that there is a need for organisations to build collaborative relationships with 3PLs and continuously update technological infrastructure in order to meet supply chain network goals.

Research Limitations/Implications:
The main limitation of the study was the low response rate because of the use of an online questionnaire and a small sample size. A small sample size implies that the findings of this study cannot be generalised.

Practical Implications:
The findings revealed that the availability of homogeneous technological infrastructure to allow processes to be synchronised was an issue. The study found that some problems existed with effectively managing relationships. These findings could be used to enhance information sharing practices thereby cultivate the management of supply chains, its operations and relationships amongst channel members.

ANALYSIS OF THE FACTORS AFFECTING TRUCKING SERVICES TO ADOPT UBER BUSINESS MODEL

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Purpose of this paper:

Truck companies have been facing challenges that includes the unstable utilization of vehicle capacity and loads finding. While the concept of Uber business model is emerging and widely applying in the passenger transport and food delivery nowadays, but the trucking service using this model is still developing. The literature indicates that such business model can increase vehicle capacity utilization, however the further and more comprehensive empirical research looking at the Uber business model in the field of trucking service is limited. Therefore, this study aims to explore the opportunity of using Uber business model in trucking services and analyse the factors affecting the trucking services to adopt the Uber model through the lens of diffusion of innovation theory.

Design/methodology/approach:

This study uses a mixed method to collect data from industry information on internet, qualitative semi-structured interview and quantitative questionnaire survey. Interviews were carried out with owners from Taiwanese leading trucking companies and on-demand trucking service platform operator to obtain the in-depth industrial insights. The questionnaire was developed based on literature and the findings from interviews. Survey data were acquired from 121 practitioners working in the Indonesian trucking companies, and were analysed using factor analysis and binary logistic regression methods.

Findings:

This research identifies at least 30 trucking service operators have started to apply Uber model to run their business. The results of interviews suggest several factors affecting trucking service to use Uber model, which were not mentioned in literature, such as specific type of cargo, and value-added functions. The exploratory factor analysis (EFA) identifies 7 factors retaining 26 variables from the 35 initial ones. Furthermore, the binary logistic regression method shows that "Operational consideration", "Value-added functions", "Legal issue", and "Sustainable" are 4 significant factor dimensions influencing truck companies to adopt Uber business model.

Value:

This study extends the knowledge of using Uber business model in trucking service, in which much research focuses on the passenger transport. It also shows the potential of this business model in Indonesia where the conventional trucking services are more available, and provide more evidences to reflect the insight of diffusion of innovation theory.

Research limitations:

The results of survey were based on the samples from Indonesian trucking operators, where the trucking services are running in a conventional business model, instead of the Uber business model. Some other countries with a more mature application of the Uber business model and the role of customers may have varied significant determinants to be considered.

Practical implications:

This study can provide the guidelines for trucking companies and truck owners to evaluate whether they should apply Uber model in their business or not. In addition, platform

service providers can also benefit from this work by improving their services to attract more trucking service providers to use the platform services.

Integrating Crowdsourced Logistics with Existing Practices to Address Last-Mile Delivery Challenges on a University Campus in China

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Purpose of this paper

Crowdsourced logistics delivery provides services usually through a platform by entrusting deliveries to ordinary people instead of businesses or its designated agents such as employees (Frehe et al., 2016). The platform is primarily used as a communication medium that can be accessed via smartphone or web browser (Ta et al. 2018) and is mainly responsible for crowdsourcing recruitment, matching customers and crowd couriers as well as formulating pricing algorithms (Frehe et al., 2016; Mason & Harris, 2019). There is a growing interest in using crowdsourced initiatives to address local deliveries challenges. This paper investigates the impact of crowdsourced logistics on other existing strategies such as parcel locker stations and collection points for on-campus last-mile deliveries in China. Also, we investigate the feasibility of using the crowdsourced delivery solution to address those challenges.

Design/methodology/approach

Semi-structured interviews were conducted with twenty participants living and working within or around the university in China. Participants include students, teaching staffs, and logistics staffs working for a campus logistics company (parcel locker loaders and collection point operators). The data was analysed against five performance objectives: quality, speed, dependability, flexibility, and cost.

Findings

The findings suggest that, although the current existing strategies (parcel locker stations and collection points) have significantly alleviated the pressure on on-campus delivery, there are still challenges that limit its performance and needs an urgent solution. The crowdsourced solution is proposed to address those challenges associated with current practices. The solution has the potential to increase efficiency, provide more convenience to customers, and establish a more positive environmental image, that takes advantage of a crowd's idle resources and under-utilized logistics capabilities through mobile connection and online platforms. However, to achieve better collaboration between crowdsourced logistics and existing strategies, an urgent need exists for service providers to develop new innovative alternatives that sort and group everyday parcels with agility based on the pre-integrated orders generated on the online platform.

Value

There is still limited research on crowdsourced logistics and this paper is one of the first paper that discusses the integration of such system with current solutions. The presented model provides new insights into this emerging concept.

Research limitations/implications

This study focuses on one public university in China and some factors related to campus layout, customer base, and campus regulations could vary among different universities. What's more, the characters of the university campus are different from that of residential areas in urban areas, therefore further research is required for residential areas.

Practical implications

Implementing a crowdsourced delivery system on the campus could improve the current performance of parcel locker stations and collection points against key objectives. It can be considered as a promising strategy when integrated with current systems for enhanced performance of campus last-mile delivery. This research highlights the operational importance of integrated practices.

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Crowdsourced Logistics Data: Understanding the Logistics Crowd

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Crowdsourced Logistics Data: Understanding the Logistics Crowd

Purpose of this paper

As traditional means of data collection has many limitations, SCM research needs to tap into novel data sources, such as crowdsourcing. However, engaging crowds is contextual in its nature and in order to apply crowdsourcing we need to understand the crowd we aim at engaging. We aim at understanding participant motivation and engagement of crowdsourcing logistics and hypothesize that participants will engage at different levels depending on the fit between the participants' identity and the identity of the group that benefits from the crowdsourcing activity.

Design/methodology/approach

We run a field experiment in which we use show participants who benefits from their contribution to the crowdsourcing initiative. The participants were exposed to one of the four different treatments, and their participation in the initiative was monitored. The field experiment is embedded in an initiative involving thousands of volunteers to track truck movements. It uses an innovative artefact (smart phone) to report data and communicate with the crowd.

Findings

Contrary to previous studies on this type of transparency involving blue collar workers, we find no discrimination bias in the activity of our volunteers. We however did find differences in how the participants political ideology impacted their engagement when receiving a politically related message.

Research limitations/implications

This research's theoretical contribution is based on applying social identity theory and operational transparency to an innovative context: crowdsourcing logistics data. We contribute to those literatures explaining how the ingroup-outgroup bias does not have an effect on this context. Furthermore, our research sets the stage for future research investigating culture and structure differences between North America and the EU and how it impacts the supply chain/logistics research.

Practical implications

Our findings can help crowdsourcing organizers to reach a greater level of crowd engagement. We contribute practical knowledge how to sustain participant contribution in a crowdsourcing logistics data initiative.

Original/value

Previous literature on logistics and operations management has emphasized the risks of negative bias when increasing transparency. This paper provides evidence of the limited effect of increasing operational transparency towards reducing the contribution of participants.

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Blockchain Technology in Supply Chains: Comprehensive Review of Theories Adopted in Existing Literature

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Purpose of this paper:

This paper aims to provide a comprehensive review of most frequently addressed theories in the field of blockchain technology (BCT) and supply chain management (SCM). The purpose of this paper is to deepen current understanding of such field and contribute to its future development.

Design/methodology/approach:

This research adopted the systematic literature review (SLR) method of Tranfield et al. (2003) to collect data from previous literature to map the use of theories in this field. Followed by descriptive and frequency analysis then qualitative content analysis.

Findings:

Most of the articles utilized already existing organizational and innovation theories to build theoretical foundation for hypothetical models. While theory building articles remain scare in this field. Common theories used were transaction cost theory, resource-based view theory, agency theory, network theory as well as Diffusion of innovation theory, United theory of acceptance and use of technology, and technology organization and environment framework.

Value:

Value of this paper lies in its focus on analysing theories proposing many reference theories to extend our knowledge of the use of BCT in SCM.

Research limitations/implications:

Only peer-reviewed journal articles were included in this SLR, hence overlooking theories that might be covered in conference papers. Additionally, this SLR included articles till early 2021, thus missing some articles that are published afterwards.

Keywords:

Blockchain technology, Supply chain management, Theories, Systematic literature review

Tendency to Adopt Blockchain Technology in Portuguese Supply Chains

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Purpose of this paper:

This paper aims to investigate the implementation potential of blockchain technology in supply chain management by Portuguese organizations, by perceiving their advantages, disadvantages, and barriers their familiarity with the concept and the adoption scenario.

Design/methodology/approach:

A systematic literature review approach to identify the main characteristics of blockchain technology to formulate a structured questionnaire to be applied to managers from food, transportation, and pharmaceutical sectors.

Findings:

A systematic literature review (SLR) approach allowed identifying items to build a structured questionnaire which demonstrates that the implementation of blockchain technology in supply chain management is a very recent topic and its characteristics of sharing information and storing data in a decentralized disturbed ledger provokes advantages in increasing traceability, certifiability, transparency, security, and self-regulation and reduces hacking risks and data manipulation by companies. Additionally, it will have the bigger impact in areas connected to finances, communication with partners and transportation. However, it was identified a low desire of implementing blockchain in Portuguese organizations, because of the scepticism and perceived knowledge about it as the absence of governmental laws and regulation. Data gathered from 48 companies, analyzed through SPSS version 27.0 revealed that the links between the variables are very weak mostly because there is a misunderstanding about BCT.

Value:

This paper provides a systematization of advantages, disadvantages, barriers supported not only by a systematic literature review but also with real data from Portuguese supply chain managers, beyond the identification of resistances, potential and knowledge regarding implementing blockchain in the organizations.

Research limitations/implications:

The study is limited to the number of answers being only from Portugal, and applied to a few industries, although it is valid for the analysis that is performed in these sectors of activity.

Practical implications:

Blockchain technology will bring several modifications of how supply chain managers take decisions in their companies. Mostly they are afraid of losing control of their own databases and sharing their information with other links of the chain, as well as the investments needed and the difficulty in implementing recent technologies

The Role of Blockchain Technology on Shaping Digital Supply Chain Features Influencing Customers Relationship: A Systematic Review

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Purpose of this paper:
The integration of Digital Supply Chain (DSC) is becoming increasingly dynamic, impacting all nodes across the supply chain, especially the players/customers down the involved which occasionally find it problematic to easily adapt to the everchanging global business trends. In the continuous race for survival, DSCs are constantly embedding new technologies to enhance their performance, such as the Blockchain Technology(BCT) as it ultimately influences the supply chain partners/customers relationship. Thus, the purpose of this paper is to propose a framework of the variables identified to illustrate the role of BCT on shaping DSC features influencing customers relationship along the supply chain.

Design/methodology/approach:
This paper conducts a thorough systematic literature review that aims to identify the characteristics of BCT and DSC features which eventually influence SC customers relationship.

Findings:
This paper explores the main variables of BCT, DSC and the key influential drivers for the players/customers along the supply chain. Accordingly, the research introduces a conceptual framework which identifies the variables of BCT and DSC and elaborates the key indicators/drivers of the supply chain customers relationship, in attempt to investigate the correlation of the variables.

Value:
To the author's knowledge, no academic papers are published in leading academic journals that investigate the relationship between BCT, DSC and SC customers relationship from a theory-based perspective.

Research limitations/implications:
The proposed framework can bring valuable insights for future research development, although it has not been tested yet.

Practical implications:
BCT and DSC encompass the potential to significantly change customers relationship along the SC. Managers, practitioners and all involved in the digitalization phenomenon can utilize the framework as a starting point for other business digitalization projects.

Performance Frontiers of Additive Manufacturing Supply Chains

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Purpose of this paper:

As the interest and hype behind the manufacturing possibilities offered by 3D printing grew, claims were made that manufacturing in local micro-factories and at home would soon become common place. However, as adoption levels in industry increased, several implementation barriers and limiting factors emerged to dampen these ambitious predictions. These barriers have been reported in the AM management literature e.g. (Jimo et al., 2019; Thomas-Seale et al., 2018), with some seeking to define the performance frontiers of AM supply chains (i.e. the limits of its capabilities). However extant research has not explored the far-reaching implications of these factors on SC design. In this paper, we discuss the salient static and dynamic factors that determine the performance of a metal AM SC and the subsequent implications for SC configuration.

Design/Methodology/Approach:

SC configuration (Srai and Gregory, 2008) and Technology Implementation theories are adopted to explore metal AM SCs for the production of end-use parts. Multiple Case studies were carried out in metal AM SCs of 15 firms that adopted AM in the Aerospace, Automotive/Motorsport and Power Generation sectors. Semi-structured interviews were conducted with key informants across three tiers of the metal AM SC, complemented with on-site observations. Within and cross-case analysis were carried out to identify salient factors across industrial sectors and applications.

Findings:

Salient factors including the criticality of industrial applications, nature of industry and the maturity levels of the AM industry need consideration in AM SC design. Factors such as application requirements and industry type are likely constants. However dynamic factors such as maturity levels could change and make existing SC configurations sub-optimal.

Value:

The research identifies the salient variables that could serve as inputs in future SC modelling studies and development of frameworks for AM SC maturity assessment and design.

Research Limitations:

Inclusion of more cases from different industries and other material SCs, such as Polymers, Ceramics etc. will enhance the validity of findings.

Practical Implications:

The research identifies critical factors for operations and SC managers to aid their implementation decisions when configuring new AM SCs or re-configuring existing ones. It highlights the importance of periodic assessment in view of the dynamic variables that may change and create scope for increased SC performance.

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PITFALLS, STICKS AND STONES: UNDERSTANDING CHALLENGES INDUSTRY 4.0 POSES FOR INTER-COMPANY LOGISTICS

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Purpose of this paper:
Industry 4.0 implies a further digitization and interconnection of industrial value creation. Given its interconnecting character, Industry 4.0 has the potential to transform logistics and entire supply chains. When it comes to inter-company exchange, Industry 4.0 brings numerous challenges but in spite of its relevance, research lacks a comprehensive understanding. Our study contributes to this gap addressing the question "What challenges and risks does Industry 4.0 bring for inter-company logistics?"

Design/methodology/approach:
Conducting a mixed method approach, the paper combines a systematic literature review with a qualitative empirical study to develop a deeper understanding of challenges and risks Industry 4.0 implies for logistics. Firstly, conducting a systematic search, we identify 69 relevant publications and analyze them according to challenges and risks. Secondly, a qualitative-empirical multiple case study, based on 17 semi-structured, inductively analyzed interviews with experts from German industrial companies, complements the elaborated categorization.

Findings:
The paper provides insights into literature and combines the findings with qualitative empirical data. The results indicate, among others, challenges and risks in the logistics sector caused by Industry 4.0 when it comes to cooperation with suppliers and partners, in the organization and implementation, regarding data management, as for human and technological aspects, and regarding legal issues and standards. Hereafter, the results are discussed against the background of scientific publications in the field of logistics and Supply Chain Management.

Value:
The study aims at developing a comprehensive understanding of challenges and risks that Industry 4.0 poses for logistics. To the best of our knowledge, this study is among the first to shed light upon Industry 4.0 challenges and risks from a logistic and supply chain lens. In so doing, we add novel insights to the current state of research and discuss aspects contributing to the scientific and practical discourse.

Research limitations/implications:
Our paper's methodology entails some limitations, for example, restrictions in the literature analysis and biases during the interviews, coding procedure, and inductive analysis. In the course of the analysis, the study reveals several implications for future research. For example, insights from quantitative analysis and best practices cases of successful implementations would complement the findings.

Practical implications:
The study provides managers with implications on how to manage Industry 4.0 challenges. Deepening the understanding may help corporate practice to anticipate challenges in advance, to analyze, and address them proactively in order to adequately implement Industry 4.0 across corporate borders.

Investigating the Barriers of the Internet of Things implementation in the automotive supply chain in Egypt

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Purpose of this paper:
Technology is quickly evolving in nearly all business sectors. Smart technologies and the Internet of Things (IoT) are changing the ways global logistics and supply chains are managed especially in times of uncertainty. Thus, the readiness of all supply chain partners is of prime importance to sustain the competitiveness of supply chain networks. This research aims to investigate the barriers which might hinder the implementation of IoT in the automotive supply chain in Egypt. The automotive sector is one of the most important sectors in the Egyptian economy and the adoption of IoT would positively impact the performance of its supply chain.

Design/methodology/approach:
This research is qualitative in nature as IoT is a novel topic in the Egyptian business community and this would require a thorough investigation and examination of insights from multiple stakeholders. This empirical study employs a qualitative methodology to investigate the barriers to IoT implementation in the automotive supply chain in Egypt in addition to provide recommendations to overcome such barriers. Data is collected through semi-structured interviews with industry experts in the automotive supply chain in Egypt. Data is analysed by interpretive structural modelling (ISM) to develop a structured model representing the possible interrelationships between the IoT barriers implementation in Egypt and MICMAC analysis.

Findings:
The ISM model for the IoT implementation barriers in the automotive SC in Egypt was found to comprise four hierarchical levels. The lack of regulations and policies, and the lack of technical knowledge among supply chain partners are the key barriers to IoT implementation. The MICMAC analysis revealed that the IoT implementation barriers are categorised into 2 the linking and driving cluster.

Value:
This research attempts to fill the gap in supply chain management and technology applications research in Egypt. It supports researchers and academics in future research. It also assists the business sector in understanding the barriers involved in IoT implementation in Egypt.

Research limitations and implications:
This research is limited to the automotive sector in Egypt. Future research can address more stakeholders in the automotive supply chain.

Practical implications:
This research is an attempt to draw the attention of the business sector towards IoT. It can also encourage policy makers to take positive initiative into facilitating the introduction and adoption of IoT in the business sector.

Keywords:
Internet of things, automotive, supply chain, Egypt, barriers

Impact of the Use of IoT, Visibility and Dynamic Data Information Processing Capabilities on Firm Performance

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Purpose

Among all the aspects of technology, the advent of IoT has deeply affected firms' approach to production and has powerfully reshaped operational and financial structures. However, the role of IoT and information visibility in manufacturing has still been understudied in the context of firm performance. This study intends to use extant literature to provide a conceptual framework that empirically tests the impact of the use of IoT, information visibility and dynamic data information processing capabilities (DDIPCs) to enhance firm performance.

Research Approach

Existing empirical and theoretical literature is critically reviewed to produce the conceptual framework.

Findings and Originality

The results obtained from the critical review show that connectivity, flexibility and agility of IoT devices are the key determinants that make use of IoT vital to gain visibility of information within a firm. Moreover, it has been found that DDIPCs have a positive relationship with the use of IoT and visibility to enhance firm performance.

Research Impact

Novel features of this study are the variables of IoT, dynamic capabilities of firms and information visibility, and the theoretical foundations for explaining relationships between these constructs and firm performance. This approach helps to better understand what, how, and why each IoT variable, DDIPCs and visibility enhance the firm's performance.

Practical Impact

The conceptual framework will help practitioners enhance operational and financial performance using IoT, information visibility, and DDIPCs in manufacturing processes.

IOT-FRESHNESS SENSOR DATA-DRIVEN PRICE INFORMATION SYSTEM FOR FOOD WASTE REDUCTION IN GROCERY RETAIL STORES

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Purpose of this paper:
Bulk fresh fruits and vegetables at the grocery retail stores are being wasted dramatically as disrupted grocery supply chains produce more food waste than ever before. Perishable foods need to be sold out before reaching the expiry date. Furthermore, insufficient market prices are likely to result in food surplus/food waste in retailers. The purpose of this paper is to meet customers' quality and price requirements while minimising the food waste (disposal of produce) and increasing the profit of the retailer. The quality loss of a perishable item occurs naturally, and it becomes unacceptable by the customers as it stays on the shelves. Computational logistics applications such as hyperspectral imaging sensors can help grocery stores to reduce the food waste and increase profit by continuously inspecting the food quality and send signals to a computer that updates the unit price based on the freshness score and the remaining quantity of the product. This study explores the food waste reduction challenge by proposing an IoT freshness sensor data-driven four-stage price information system.

Design/methodology/approach:
In this paper, the food waste problem at the retailer stage is highlighted and an IoT freshness sensor data-driven four-stage price information system is proposed to reduce food waste by performing a pilot project for bulk apple sales. A multi-stage dynamic programming method is used to decide on a pricing strategy for the bulk produce, where real-time IoT sensor data retrieved from hyperspectral imaging sensors is employed to analyse and determine the length of freshness stages. Monte-Carlo simulation is employed to model the daily operation of a grocery store, and a numerical example is performed to illustrate the practicability of the proposed model.

Findings:
The model is simulated according to scenario-based and parameter effect analysis. Simulations were run to analyse the effects of sales price, the replenishment amount and the discount rate on profit and food waste and also effect of freshness score on profit and inventory level. The analysis show that these parameters have significant effects on the food waste of the grocery store.

Value:
The novelty part of this paper is to present a real-time IoT sensor data-driven dynamic model to decide pricing at different stages of a sales season at retailers in the perishable food supply chain for the first time, to the best of our knowledge, in a research work in the literature.

Research limitations/implications (if applicable):
In this research, freshness sensor data retrieved from hyperspectral imaging sensors is used to determine price strategy of produce and the Monte-Carlo simulation is conducted to model the daily operations of grocery store.

Practical implications (if applicable):
This proposed system is useful for the grocery stores to reduce their food waste, if any grocery supply chain disruption such as due to COVID-19 pandemics occurs.

SECTION 2 – GLOBAL SUPPLY CHAIN COMPLEXITY & MANAGEMENT

Investigating Outsourcing Logistics Service Quality Level of Pharmaceutical Enterprises: the case from China

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Purpose of this paper:

Currently China is the second largest pharmaceutical market around the world, outsourcing service quality has become a major management issue for every pharmaceutical company. The three main purpose of this study are to identify the major status quo of Chinese pharmaceutical enterprises' outsourcing logistics service quality, the major opportunities appealed, and the challenges confronted.

Design/methodology/approach:

This study thus aims to apply Refined Kano Theory to construct medical institutions' satisfaction and perceptions of the importance of Chinese pharmaceutical outsourcing logistics services and examine its impact on logistics service performance. The Structural Equation Modelling (SEM) is applied to analyse the structural relationship between logistics service quality and latent constructs.

Findings:

This research reveals the quality level of outsourcing logistics services of China's top 100 pharmaceutical enterprises.

Value:

The present research contributes to the literature by demonstrating that the provision of high-value-added and crucial quality attributes can give service providers an edge in the market.

How the Fashion Industry Reduces Time-to-Market from a Supply Chain Perspective – A Case Study on ZARA and adidas CORE

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Purpose of the paper:

Getting products to market in a shorter time enables a fashion brand to savor the trend in vogue and can start preparing new products later than its competitors. Shorter time-to-market could help reduce product inventory risk because not only might the design fit the market better, product replenishment can be fulfilled in a shorter time. ZARA is one of the apparel fashion brands best able to reduce finished product inventory and respond quickly to market demand; adidas CORE is a reasonably-priced fashion sports shoes targeting at younger consumers and seeking to capture market share through a responsive market strategy. Because apparel and shoes have different product structures and production processes, the supply chain design and management engaged are different. This study employed a case study method to investigate the bullwhip effect and responsiveness of ZARA and adidas CORE, and also examine the use of postponement strategies and concurrent engineering to achieve quick response.

Design/methodology/approach:

We studied fashion industry supply chain and manufacturing strategies, especially those related to design, purchasing, postponement, inventory control, production, logistics etc. that could lead to lead time reduction. ZARA and adidas CORE were used as two cases to verify the theoretical findings through direct observation, interviews and document review.

Findings:

In order to reduce out of season unsold inventory while also responding to market demand quickly, under this premise, ZARA and adidas CORE both adopted postponement strategies in their supply chains and manufacturing systems. They also adjusted production to ensure that customized processes are delayed at the postponement point until the demand is confirmed. However, due to different production structures of apparel and shoes, their postponement points are also differentiated. In addition, the two brands both use anticipatory business models in conjunction with their postponement strategies to prepare for rapid production. Because shoes require many different types of materials, to shorten development time, adidas embraced the concurrent engineering concept by inviting vendors to participate in the development process. After products have reached the market, in accordance with their sales situation, ZARA may adopt a responsiveness business model for quick response, while adidas CORE maintains a brisk production and shipment pace in order to supply the market without interruption.

Value:

The case study rationalizes from supply chain perspectives regarding how those fashion brands could make their products to market in a short time. The effectiveness of short lead time can also be confirmed from the metrics in inventory level and profits.

A CONTENT ANALYSIS OF THE BARRIERS AND CHALLENGES ASSOCIATED WITH THIRD PARTY LOGISTICS: A COMPARISON OF THE UK AND NIGERIA

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Purpose:
The aim of this paper is to identify, rank and compare the barriers and challenges associated with the practice of logistics outsourcing in the UK and Nigerian in order to find out why it is less practiced in Nigeria compared to the UK.

Methodology:
The research is an exploratory research using content analysis. Secondary data was gathered from various sources such as academic journals, business magazines, online newspapers, databases such as ABI/INFORM, GMID, World Bank database and statistical database websites such as Statista, Mintel, Ibis World, Armstrong and associates, Mordor Intelligence and ReportLinker. These foregoing sources were systematically searched and reports such as UK logistics industry reports, UK contract logistics company report, Nigerian logistics risk reports, Nigerian 3PL market report, academic journal reports, newspaper and magazine content and data from GMID and World Bank database were reviewed. The findings of the review were then ranked according to frequency of occurrence showing priority of barriers and challenges of 3PL in both countries.

Findings:
Findings show that UK logistics industry and 3PL market is more matured than the Nigerian logistics industry and that UK contract Logistics companies rank among the top logistics companies globally. Further evidence shows that UK logistics industry and 3PL market is forecasted to continue to grow slowly despite few mild challenges while the Nigerian 3PL market shows significant promising future. Furthermore, 15 barriers and challenges were identified in Nigeria while 6 barriers and challenges were identified in the UK with less frequency of occurrence. Among the top three major barriers identified in Nigeria are congested road networks and ports (7), security issues such as smuggling and robbery (7) and high rate of traffic accidents (6). In the UK the top three major barriers identified are: driver/labour shortages (2), rising fuel prices (2) and click and collect (1).

Value:
The research gives preliminary insights and explanations into the reasons for the lower level of logistics outsourcing in Nigeria compared to the UK by identifying and ranking the barriers and challenges of the 3PL market in Nigeria and the UK. While there are academic literature that have argued that logistics outsourcing is less practiced in developing countries than it is practiced in the developed countries such as the UK, other European countries and the USA, not many have been able to provide insights for the difference in levels of logistics outsourcing practice between a developing country such as Nigeria and a developed country such as the UK. The research is hence valuable to the logistics academia, 3PL practitioners in Nigeria and the UK and to any Nigerian or UK potential 3PL investor or customer.

Practical implications:
The results from this study can be used to inform the development of a Nigerian specific decision support framework/tool for organizations in any industrial sector wishing to contemplate the use of third party logistics products and services. It may also inform the investment decision of potential foreign 3PL investors in the UK and Nigerian market.

Why Digitalization Matters for Oil and Gas industry in Egypt?

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Purpose of the paper

Most of today's digital initiatives in oil and gas are incremental rather than disruptive. Some companies are taking a step forward to make improvements in technical or operational capabilities, but many are not fully embracing the power digitalization can provide. Numerous benefits such as increased cost savings and significant improvements in collaboration, productivity, maintenance and revenue have been realized through digitalization.

Design/methodology/ approach

The methodology proposed follows a qualitative approach using a questionnaire-based was carried out among Egyptian oil and gas companies directed to owners and managers. The proposed methodology will clarify how Oil and gas companies have understood the importance of digitization and are improving their supply chains by employing digital strategies, using smart manufacturing, designing digital business models and using data analytics as core competencies,

Practical implications/ findings

The findings reveal the importance after conducting regression analysis among Egyptian oil and gas companies, besides addressing the challenges call for better evidence to target actions and promote solutions. This all aims at creating an enabling oil and gas Egyptian companies to move towards digitization which will boost the up and downs oil and gas supply chain. Also focus on creating optimal economic and social transformation triggered by the massive adoption of digital technologies to generate, process, share and transact information that influences the digitization within the overall supply chain and ultimately to improve supply chain visibility.

Originality/value

This paper will investigate the impact of digitization on oil and gas supply chain performance in Egypt highlighting the vital factors that directly affect the entire supply chain operations and producers. In addition to, the challenges that faces implementing technological concepts and efficiency in exchanging information to obtain better capabilities calls for better implementing and establishing the digitization concept.

ADEQUATE MOTOR VEHICLE MAINTENANCE BY ANALYSES AMONG FAILURE PARTS AND USAGE ENVIRONMENT

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Purpose of this paper:

Motor vehicles namely trucks and lorries play important role in cargo transportation in modern society. Maintenance of them becomes essence of on time delivery and business reliability. In fact, they convey more than 90% of freight tons and 50% of freight ton kilometres inside Japan in 2018. Decision makings during the maintenance, where to be fixed or which is going to fail, are however much depend on experience of assigned mechanic staff except for periodic inspection designated by law. Inadequacy maintenance may cause high maintenance cost according to excess work and replaced parts. On the hand, it may lead higher risk on cargo transportation such as sudden breakdown. By supporting mechanics, proper maintenance will enhance business of transportation company and motor vehicle manufacturer. In this paper, we present analyses on failure parts and usage environment to support adequate maintenance in service garage.

Design/methodology/approach:

Authors have collaborated with a motor vehicle manufacturer in Japan and obtain maintenance record data of service garage. The system is commonly used in service garage related to the manufacture. The data consist of about 800 thousand records derived from an Information System that is implemented for payment calculation.

In this paper, we present two analyses on the data. The first one is an analysis between failure parts and truck environment such as traveling distance. A Bayesian network are conducted to represent the effect of environments.

The second one is an analysis among failure parts to see effect that an inadequate part may cause trouble on another part. Conditional probabilities are used in the analyses.

Findings:

We have focused on four exhaust gas related parts. There is a tendency kind of failure parts changes according to travel distance increase according to the analyses with Bayesian network.

For analyses among four parts, we focused relationship between Part X and Part Y where Part Y was replaced after replacement of Part X. This represents a scenario that trouble of Part X causes failure of Part Y. Through the analyses, we found some weak tendencies between parts. With these outcomes we are going to build more detailed hypothesis for farther analyses.

Value:

We have many literatures about analyses for parts reliability such as bathtub curve. However, analysis of huge maintenance records is not seen. Furthermore, this kind of analyses will contribute management of logistics company and motor vehicle manufacturer.

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Locating charging stations and routing drones for efficient automated stocktaking in warehouses

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Purpose of this paper:

Drones have received growing attention in logistics recently. One of the most promising use cases for indoor drones in warehouses is stocktaking (Wawrla et al., 2019), which is the physical verification of the quantity of items stored in warehouses. This task is cost-intensive as it is typically performed by inventory control staff, who usually walks or drives to designated locations in the warehouse, scans barcodes of the items or manually counts them. With the use of drones, warehouse managers can increase inventory record accuracy and decrease labour costs. The purpose of this paper is to formulate and solve the stocktake drone routing problem (STDRP), which consists of the routing of a fleet of drones through a warehouse for stocktaking purposes as well as deciding on the location of charging stations on the warehouse floor. We evaluate the performance of the proposed algorithm and present managerial insights for managing stocktake drones in warehouses.

Design/methodology/approach:

We formulate the STDRP as a mixed-integer programming problem and develop an adaptive large neighbourhood search (ALNS) with novel solution encoding and decoding approaches to solve the STDRP. ALNS is based on the large neighbourhood search (LNS) introduced by Shaw (1998). In a LNS, the neighbourhoods are defined by destroy and repair operators. A destroy operator is used to remove a set of vertices to cut the present solution into parts in each iteration of the search. Then, a repair operator is used to create a new solution. ALNS was developed by Ropke and Pisinger (2006) and extends the LNS by an adaptive selection mechanism for choosing a destroy and repair operator in each iteration.

Findings:

The proposed solution procedure minimizes the number of drones required for completing a given stocktake, which enables warehouse managers to minimize investment cost and speed up the stocktaking process.

Value:

Traditional stocktakes have been described as expensive due to the high amount of manual labour required. Using drones for inventory management can increase inventory record accuracy, decrease labour costs, and minimize dangerous tasks for the workforce. The results of the paper at hand are valuable for warehouse managers that are interested in using stocktake drones.

Research limitations:

Our meta-heuristic solution procedure is only applicable to a one-block warehouse. To apply it to other warehouse layouts, a modification is required.

Practical implications:

The model proposed in this paper supports an efficient use of drones for stocktaking purposes and can inspire a more frequent use of this technology in practice.

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ANALYZING BARRIERS TO THE DIFFUSION OF ELECTRIC VANS IN CHINA: A MULTI-STAKEHOLDER PERSPECTIVE

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Purpose of this paper

The purpose of this paper is to identify key barriers to the development of electric vans (EVs) in China, analyze the importance of these barriers, and reveal their causal relationships.

Design/methodology/approach

We investigate barriers to the diffusion of EVs in China from the perspectives of EV manufacturers, distribution companies, and charging infrastructure operators. We use the Best Worst Method and fuzzy DEMATEL technique to identify the importance of these barriers and investigate the cause-effect relationships among them based on interviews and industry expert surveys.

Findings

We find the most critical barriers to the diffusion of EVs in China are: demand uncertainty, lack of cost advantages, lack of suitable application scenarios, and the relatively long charging time. Lack of mature battery technology, the relatively long charging time, lack of suitable charging infrastructures, and insufficient traffic incentives are the four most important cause factors.

Value

This paper contributes to revealing key barriers influencing the development of EVs and clarifying their causal relationships, which gives a systematic understanding of the multifaceted nature of EV barriers and their inter-dependent relationships. Our study can help provide targeted policies, incentives, and strategies to mitigate high-priority barriers.

UNDERSTANDING UPGRADES-AWARE OVERBOOKING POLICY

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ABSTRACT:

An important challenge faced by airlines is to minimize losses due to involuntary denied boarding that occurs as a result of overbooking. Characterized by narrow profit margins and intense competition, these losses significantly impact revenue as the airline industry is making profits mainly through ancillary services. Seat upgrades, a capacity-constrained ancillary and a technique to mitigate involuntary denied boarding, has helped airlines enhance profits by offering flexibility and risk-pooling benefits. Considering the potential of upgrades, we analyze a profit-maximizing overbooking policy for a single-leg, two-cabin class flight that considers variability in demand, ticket prices, denied boarding costs, and no-show rates for both the classes. We assume that passengers are willing to accept upgrade offers when an upgrade is offered and use a decision-tree based model using realizations to facilitate the analysis. Analytical proofs depict that upgrades increase both the optimal overbooking limits and the net revenue, while numerical example substantiates the proofs. Furthermore, we find that upgrades result in increased denied boarding, which calls for upgrade-aware overbooking policy, i.e., imposing service-level constraints to maintain airlines' reputation.

SECTION 3 – LOGISTICS NETWORK DESIGN, ANALYTICS & MANAGEMENT

Multi-channel supply chain management: A systematic review of the literature

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Purpose of this paper:

To reach more customers, many manufacturers utilize multiple distribution channels (Chung et al., 2012). If a manufacturer markets its products through its website (online) or company-owned (brick-and-mortar) stores, a direct sales channel is used. In indirect sales channels, the manufacturer sells its products and provides services through intermediaries (e.g., retailers, e-tailers, wholesalers; see Rosenbloom, 2007, Coughlan et al.,2006). In distribution systems where manufacturers operate one or more direct distribution channels in addition to selling products via retailers, the retailers may perceive the manufacturer's direct sales activities as a threat.

In this context, this working paper aims to provide a systematic and exhaustive review of multi-channel distribution systems. The various net-work designs selected by a manufacturer and the mitigation tactics for arising competition between manufacturer and intermediaries are dis-cussed in this paper. Our objective is to consolidate existing research on multi-channel distribution systems and to identify research gaps that need to be addressed in future research efforts.

Design/methodology/approach:

The focus of our study is on a manufacturer that competes with its independent intermediaries by adding a wholly-owned direct sales channel. Via two scholarly databases, namely Scopus and Business Source Premier (via EBSCO Host), we systematically searched for relevant analytical works that fall into our scope. To organize our discussion, all works obtained during the literature search were classified and evaluated in accordance with the following two research questions;

1. RQ 1-How does the manufacturer configure his network?
2. RQ 2-How does the manufacturer manage channel conflicts?

Findings:

All works (165) obtained during the literature search were evaluated in light of the research questions. RQ 1 investigated the network configurations studied in the sampled literature. Related works were classified primarily under two-tier, three-tier, and closed-loop supply chain network designs. Most works in our literature sample studied two-tier supply chains in which a manufacturer distributes the products both directly and via a retailer; these structures are usually referred to as dual-channel supply chains.

The second research question (RQ 2) evaluated possible mechanisms that the manufacturer could adopt to mitigate emerging conflicts with the retailers. The related findings showed that research on multi-channel distribution systems had a strong focus on developing and evaluating contracts to resolve channel conflicts.

Value:

To the best of our knowledge, this study will be the first systematic literature review that addresses manufacturer-retailer competition in a multi-channel context.

Research limitations/implications (if applicable):

The review was limited to articles published in English that appeared in peer-reviewed journals. Other sources, such as books or conference proceedings, could contain relevant works as well. Moreover, empirical studies could be included in the scope of the literature sample.

Practical implications (if applicable):

This study may provide insights to practitioners in terms of strategic and operational decision-making in multi-channel distribution systems.

WHAT CONSTITUTES LOGISTICS INNOVATION? A CASE STUDY OF THE GERMAN LOGISTICS AWARD

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Purpose of this paper:

Despite the importance of logistics innovation, not many academic papers discuss this topic in detail, even less consider the contents of logistics innovation. Other perspectives, e. g. organizational structure and process management, have attracted much more attention in logistics innovation research. The purpose of this paper is to contribute to the understanding of logistics innovation from a content perspective.

Design/methodology/approach:

We have conducted a case study of the German Logistics Award (GLA), an innovation award, for which BVL, the German Association of Logistics Professionals, invites project proposals on an annual basis. In our study, we followed an interpretivist and social constructivist approach using two streams of data (1) archival data for the award-winning projects for the five years from 2015 to 2019 and (2) in-depth interviews with the BVL management as well as members of the GLA jury. Using MaxQDA, we applied Qualitative Content Analysis to the data to investigate what constitutes logistics innovation.

Findings:

Logistics innovation is rarely the lead implementation of groundbreaking new technologies in the field of logistics but is perceived as architectural innovations based on novel reconfigurations of existing technology. Although technology, and especially technology facilitating the digital transformation, is a central aspect of logistics innovation, the key innovation lies in delivering consistency, i.e. a holistic integration approach in terms of both reach (across departments and/or supply chain partners) and depth (tying together physical processes and information flow as well as harmonizing automation and human work, etc.).

Value:

Our study contributes to the understanding of logistics innovation from a content perspective. It showcases the role of logistics as a key driver of corporate change and highlights the importance of consistency for gaining a sustainable competitive advantage.

Research limitations/implications:

Logistics innovation as it is visible in the GLA-winning projects is socially constructed by the GLA jury. Further research should investigate whether the jury's concept of logistics innovation resonates with the industry on a broader scale. An empirical survey of logistics executives is required to better understand if striving for consistency, as our study suggests, is driving the innovation cycle in logistics.

Feasibility Study of Inter-company Manufacturing Alignment Model: An Industry-based Research Recommendations and Critical Success Factors

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Purpose of this paper:

The COVID-19 pandemic has caused a significant interruption in manufacturing and supply chain functions of the global enterprises. As a result, the national, regional and inter-continental industrial commerce levels have contracted, with dire financial consequences on specially small and medium size companies. However, a few corporations have resorted to progressive approaches for business continuity. French conglomerate, Louis Vuitton, shifted production lines from perfume to hand sanitizer [1]. London-based gin producer, 58 Gin, stopped distilling small-batch gin in exchange for large-batch hand sanitizers [2]. U.S. car manufacturer, General Motors, and Chinese iPhone manufacturer, Foxconn, converted production to surgical masks [3]. Based on a solicited request, our study included five companies within an international division for investigation and recommendations on the future feasibility of their inter-company business alignment.

Design/methodology/approach:

Our business alignment model is based on the notion of "Build anything, anytime, anywhere," while our target research client consists of a global manufacturing division with two companies in the U.S. and one in Germany, China and India, each. The manufactured products consist of compressors and expanders that are used in the natural gas exploration around the world. After an initial library research, we discovered that 60%-70% of business alliances fail [4]. Hence, we thoroughly interviewed and utilized questionnaires from the above five companies. Our final recommendations are based on the Interfirm alignment as deployed through the concept of Yokoten, a Japanese term meaning, "best practice sharing" [5].

Value:

Our research includes an extensive set of recommendations, and the corresponding critical success factors, in organizational, managerial and technical categories of inter-company alignment. We believe these recommendations may have potential values for pilot projects within enterprises that are seeking a more robust alignment.

Research limitations/implications:

Strategic alliances certainly may be constrained by a number of cultural, legal and environmental issues. Hence, we believe this phase of our research findings may be limited to, and more suitable for, commerce within the same country or possibly continent.

Practical implications:

In order to experiment with the concept of manufacturing strategic alliances, we suggest interested company leaders first apply our technical recommendations, while on a parallel basis explore and analyze the managerial and organizational alignment requirements.

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Building Information Modelling and the Supply Chain: A Review of the Literature and a Research Agenda

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Purpose:

BIM has been proposed as an integrated technology to transform the construction industry, facilitate communication between supply chain actors and improve fragmented practices (Bryde et al. 2013). However, adoption and implementation of BIM across the whole supply chain has come with its own challenges. Previous literature has identified BIM benefits, challenges and enablers from the perspective of certain supply chain actors. Yet, very few studies addressed the supply chain as a whole system and there is no previous comprehensive literature review bringing together the body of knowledge of BIM implementation across the supply chain (Papadonikolaki et al. 2017). The aim of this study is to evaluate the supply chain management/BIM literature to categorise utilised research methods, adopted theoretical lenses and identify insights for different supply chain actors and ultimately propose future research directions.

Design/methodology/approach:

A systematic literature review approach was adopted. A structured search was performed using Scopus, Science Direct, Google Scholar, EBSCO and ProQuest, employing predefined key words. Initially Level 1 key words: "Building Information Modelling AND Supply Chain AND Construction", whereas Level 2 keywords included one of the following words: "Project, Client, Contractor, Subcontractor, Procurement, Designer". Only peer reviewed English language, full text, full access journal articles, with no timeframe, were included. Articles were categorised according to their supply chain actor focus and the research methods and theories adopted, and further coding was undertaken to identify key themes.

Findings:

43 articles were identified and analysed. From the analysis, case study and mixed methods are the most popular research approach with a total of 14 and 10 studies respectively. 29 studies followed the A-theoretical approach and only five papers use a diffusion of innovation theory perspective. The thematic analysis indicates that the literature has predominately focused on individual supply chain actors while neglecting the viewpoints of lower tier actors, where 11 studies focused on the client but only six included the perspective of sub-contractors.

Value:

This study provides insights into the reasons behind the low adoption of BIM across the supply chain as one integrated system. Also, it highlights important methodological and theoretical approaches utilised in supply chain management and BIM research.

Research implications:

This study identified that BIM supply chain research still at an infancy stage. There is a need for more research to investigate the benefits, obstacles and enablers in BIM implementation across the supply chain as one interconnected system, taking into account an inter-organisational perspective. More research is also needed to exploit various methodological approaches and testing different theories to enhance research quality.

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The use of Business Analytics in Supply Chain Systems: a Perspective on Prescriptive Analytics

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Purpose of this paper:

Different business analytics approaches are used by organisations to create values from data available to them. However, organisations are not operating in isolation as they form links and connections with many other organisations who all seek to create value from data and maintain their competitive position in the current market. The scope of this paper is to clarify the possible opportunities offered by business analytics in the context of complex infrastructures such as the supply chain.

Design/methodology/approach:

From reviewing current literature, it is evident that the debate between the use of technology (Frederico et al., 2019), the application of business analytics and modelling in supply chains with their reported benefits but also limitations is a continuing battle (Tipi, 2021).

The approach adopted in this research is to take a critical view on understanding the opportunities offered by business analytics and more specifically prescriptive analytics in the context of supply chain systems by reviewing current literature and reporting on key findings. Prescriptive analytics approaches (including methods such as mathematical programming, simulation, evolutionary computation, machine learning and others) have been reviewed in recent years (e.g. Lepenioti et al, 2020), however more is still expected in the context of supply chain.

Findings:

Based on findings from the literature on business analytics the discussion brings a critical view on the opportunities offered by prescriptive analytics in the context of complex supply chain systems and management.

A categorisation of various business analytics and modelling techniques that have listed benefits are emphasised in this paper but not only. The discussion goes further and brings not only the benefits, but also current limitations (Arunachalam et al., 2018) reported by practitioners when using analytics and modelling tools with specific reference to prescriptive analytics.

Value:

This work will capture practical benefits offered by business analytics to complex systems in the context of supply chain with specific reference to prescriptive analytics. Several insights are provided that contribute to the current research agenda in the field of business analytics and supply chain modelling.

Research implications:

This work brings theoretical contributions to the field of business analytics, system complexity and supply chain modelling.

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Sales and Operations Planning (S&OP) - Definition versus Reality

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Purpose:

This paper raises the question of whether S&OP has a role to play when it comes to enabling strategic decision making. By recognising the difference between the typical definition of S&OP versus where the value focus is concentrated, the paper highlights the lack of focus of S&OP in the strategic alignment area and suggests that in addressing this, the academic community should include a focus on a complimentary process, called Integrated Business Planning (IBP).

Design:

This paper is based on a review of the literature addressing S&OP. The review was conducted in parallel both in peer reviewed literature (academic literature) and business & trade literature (grey literature) in order to elucidate the lack of focus on the strategic alignment part of the S&OP definition in conceptual terms and in practice.

Findings:

The review of these literatures point to substantial attention given to S&OP in both academic and grey literatures. A review of the academic research on conceptualising S&OP through various frames of reference, shows a clear focus on the supply chain alignment and associated decisions, of the S&OP definition and a distinct lack of focus on the strategic alignment aspects and associated strategic decisions (Pereira, et al., 2020; Kristensen & Jonsson, 2018). This lack of focus is also reflected in the grey literature where it is either expressed as a lack of maturity of the S&OP process (Alexander, 2013) or that this focus should be left to the complimentary process of IBP (Alle, 2020).

Value:

The paper is designed to trigger a call to action to investigate the lack of academic focus on the strategic alignment aspect of S&OP and the associated strategic decisions it should be enabling. In doing so it brings attention to the complimentary process of IBP that may hold the answer to closing this gap.

Research Implications:

The paper leverages a review of the literature to create a clear picture of the gap in the academic focus when it comes to the strategic alignment aspects of the typical S&OP definition. In doing so, it introduces IBP as a process that in practice is focused in this area and therefore should receive more focus from the academic community.

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Self-adaptive KANBAN-based Material Supply

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Purpose of the paper:

Since long, KANBAN is used in industry as an effective approach to provide the required materials to the shop floor. In its traditional form, the parameters for KANBAN, that is for each material the number of boxes and the quantity per box, are static, i.e. calculated initially and, if at all, re-calculated only if someone suspects the parameters to be sub-optimal. This paper shows how a traditional KANBAN system can be converted into a self-adaptive KANBAN, where the parameters are dynamically adjusted to reflect the dynamics of the environment. The self-adaptive approach aims to set KANBAN parameters in a way that shop-floor inventory is at a viable minimum without compromising production output.

Design/methodology/approach:

Using a simulation of the process of supplying material, we suggest an optimization method based on Evolution Strategies (ES). The strategy aims at finding the minimum quantity of material supply per box, while maintaining production efficiency, by dynamically and iteratively adjusting (self-adapt) KANBAN parameters.

Findings:

Compared to the traditional KANBAN approach, self-adaptive KANBAN is more flexible and efficient in unstable production environments, in which key variables are volatile, e.g. demand because of changes in the model mix or replenishment lead time due to the variability of capacity in picking and in-house transportation. In these cases, self-adaptive KANBAN can adjust material supply parameters for stabilizing the production output by avoiding material shortages while, at the same time, reducing on-hand inventory.

Value/Originality:

We provide an approach based on evolution strategy (ES) that aims to optimize the KANBAN system parameters automatically. We implemented a simulator for a lab-based manufacturing environment, SimCar, that relies on KANBAN-based material supply. The simulation study shows that the ES algorithm is capable of coping with two target objectives at the same time, productivity as the primary target and shop-floor inventory as the secondary target.

Research limitations/implications:

Data for this study has been collected from a simulation study, resembling SimCar, a lab-based manufacturing environment. More case-study research is required to test the approach in large-scale industrial applications. A closer look at the mutation strength σ, a key parameter in ES, is required to define a strategy for selecting the "best" σ for a certain situation. Furthermore, in essence, the self-adaptive approach is still reactive. For a proactive approach, it would be necessary to establish deep-learning algorithms on extensive data sets (including, but not limited to, availability and utilization of transportation and picking capacity) collected from the manufacturing environment.

SECTION 4 – BUILDING SUPPLY CHAIN RESILIENCE

Dynamic assessment of Food Supply Chain operations' impacts through a Digital twin platform

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Purpose of this paper:

Seeing the complexity of food supply chains (FSCs) and the multitude of actors involved, the operations visibility of practitioners, consumers and decision-makers is scarce. Despite traceability architectures shed light on some supply chain stages, allocating impacts and costs generated throughout the distribution network is challenging. Unfair conservation conditions, inefficient vehicle utilization, and drawbacks of management and control tasks, result in different costs and impacts generated by food distribution. The aim of this paper is illustrating how virtual platforms i.e. digital twins, contribute at increasing consumers' trust and controlling the supply chain costs and impacts.

Design/methodology/approach:

This paper illustrates the FSC's impacts obtained by a flexible digital twin platform able to virtualize real-world distribution operations. The illustrated platform replicates the processing, packaging, storage, and distribution of food and quantifies the related costs and the impacts allocated to the single lot of product.

Findings:

Through this platform, costs and environmental impacts are punctually calculated for each lot of food as a consequence of the decision made by the user at tactical and operational level. It comes out that whilst passing through the same supply chain stages, the combination of exogenous conditions (e.g. weather conditions, traffic, season), and endogenous aspects (congestions, bottlenecks) influences the costs and impacts of food lots differently.

Value:

This research and the proposed digital twin pave the way for implementing real-scaled supply chain control systems able to increase visibility and control of food operations and to lead managers, practitioners and consumers toward more convenient and sustainable choices.

Dealing with Disturbances in the Food Supply Chain for Perishable Products

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Purpose:

The purpose of the study is to explore the disturbances (i.e. risks and uncertainties) faced by wholesalers, retailers and caterers in the perishable food supply chain and investigate how organisations deal with those risks and uncertainties to mitigate the potential impact.

Methodology:

The study adopted a qualitative research approach. 23 in-depth semi-structured interviews conducted in 17 companies in the fresh food industry based in the UK and China.

Findings:

Through the interviews, the research identifies the common risks and uncertainties in operations with pieces of evidence; in that respect, it provides new insights to the disturbances that perishable food supply chains face considering the impact of COVID-19. The paper presents an overview of the current status of the perishable food industry and discusses the internal causes of vulnerability, as well as the approaches that companies adopt to deal with the disturbances and the relevant effects.

Research limitations/implications:

90% of the 17 companies involved in the study were Small and Medium Enterprises (SMEs), in the seafood or fruit and vegetable supply chains, meaning the study provides useful insights to these organisations.

Originality/Value:

The paper proposes a conceptual framework that captures disturbances in the perishable food supply chain with "supply-side disturbances", "demand-side disturbances" and "operational disturbances" and the relationship among them. This allowed for a clarification of risks and uncertainties, particularly in the period that COVID-19 impacted the relevant supply chains. The paper also reviews the approaches that businesses currently implement to cope with hazards.

Developing Resilient Seafood supply chains – A Delphi study

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Purpose

Much discussion has been undertaken in both academic and practitioner circles around the future of seafood chains, building resilience to supply chain shocks and ensuring a sustainable business model for all. Despite this existent body of knowledge, it became increasingly apparent that no 'one view' of the challenges existed, which compounds issues around engagement and identification of funding to build food chain resilience.

In addition, the data poor nature of UK fisheries has created challenges when implementing policy, enforcing conservation measures, managing sustainable fisheries, matching domestic consumption changes and increasing traceability of imports and exports. Therefore, SeaFish, a DEFRA Non-Governmental public body commissioned a research study into the enduring technological challenges facing the UK seafood industry.

Methodology

This research process deployed a Delphi process, a proven methodology for eliciting opinion from expert stakeholders and upheld by scholars as espousing more reliable results whilst reducing bias. In doing so the research team engaged with 50 industry professionals from a cross sectional sample to ensure a holistic supply chain approach was taken. This included engaging with stakeholders from fishery through to food service in fostering an end-end supply chain approach to the research whilst ensuring respondents were geographically dispersed across the United Kingdom, giving a true industry wide representation.

The process of research review spanned three elements. Firstly, researchers engaged with 50 stakeholders via email, from the Sea Food industry, over a period of 6 months to answer the question 'what are the top technical enduring challenges to the seafood industry'? Secondly, the research process undertook a detailed review into existent academic research into technology and the seafood industry. The third and final step compares existent research to the outputs of the Delphi study, which delivers a set of key challenges that industry require resolution against.

Findings

The Delphi research delivered outputs allied to 13 areas (Traceability, Technology, Landing obligation, Crew welfare, Packaging, Brexit, Labour, Public perception, Quota, Sustainability, Eco-labelling, Food waste and Shelf life) which were compared to the current academic research to identify gaps in current thinking and give direction for future proofing the industry.

Moreover, the intention is to use the output of this research to inform academics and funding bodies so that their innovation programmes can be more effectively targeted to industrial need. Therefore, the research team conducted a correlation analysis of digital and technology solutions allied to innovation across the 13 thematic areas, which identified 8 (62%) as being directly related either through their connection to process or historic research positioning

Value & practical implications

The research process has identified gaps in current research and thematic areas that are being utilised by SeaFish and feed into the SeaFood 2040 strategic fisheries review, in particular feeding into recommendation 17 to build greater resilience to seafood supply chains, through greater technical and digital connectivity.

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Corporate Culture and Supply Chain Success – A Qualitative Analysis from the Food Industry

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Purpose of this paper:

In order to be successful in the long term, companies in the food industry deal with the efficiency of their supply chains. The aim is to achieve the greatest possible supply chain success (Magnus 2007). A trend towards outsourcing of entire production processes with intensive supply chain partnerships between economically and legally independent companies can be observed (Giesen and Hillbrand 2012). Within the framework of these interorganizational supply chains, the supply chain partners always operate in the context of their corporate culture. It is therefore surprising that the topic of corporate culture has not been considered in the current supply chain research in the context of supply chain management. In this paper the authors present results from a study which shows the relevance corporate culture for interorganizational supply chain success across various functions.

Design/methodology/approach:

This paper focuses on the results of a qualitative examination in the form of expert interviews using the example of a food manufacturer. Experts from various functions have been interviewed to the topic of corporate culture and its success in the daily supply chain management. As the corporate culture from supply chain partners is a rarely discussed topic in supply chain management, the interview partners needed to get guided by using qualitative questioning tool and many examples from real supply chain collaborations to detect the experienced role of corporate culture in different and real supply chain scenarios. To verify the results from then qualitative interviews and to increase the objectivity of the research, the Structure Laying Technique was applied at the end of each interview. All interviews have been transcribed and afterwards analysed with the help of MAXQDA, a software program designed for computer-assisted qualitative.

Findings:

As a central result of the content analysis according to Mayring, it is noted that all interlocutors consider the topic of corporate culture relevant for supply chain success. The corporate culture has an influence above all on transaction factors in collaboration and coordination processes. The most important value dimension of the corporate culture can be identified as the willingness to cooperate with the partial aspect of openness and honesty. This seems absolutely comprehensible, since interorganizational supply chain success is always as well a cooperation success between at least two companies. Flexibility, participation, novelty, creativity, market orientation and autonomy are considered to remain important for supply chain success. The impact between openness and honesty, flexibility, market orientation as well as novelty and creativity can be revealed. In addition, quality awareness must be taken into account as an additional value dimension

Value:

This research shows the importance of the corporate culture for the success of supply chains management. The corporate culture of supply chain partners needs to get integrated into the agenda of make or buy decisions and get followed up like other supply chain capabilities – for new and existing supply chain partners. The more outsourcing becomes relevant for companies, the more they become depended on supply chain partners and the more the corporate culture of supply chain partners will become a factor of success.

Practical implications (if applicable):

Paying attention to the topic of corporate culture in supply chain collaboration can make the difference in these times where not only companies but end-to-end supply chains state in competition against each other. The choose of the right supply chain partner with the adequate corporate culture can support the supply chain success by increasing flexibility and reduce operational issues.

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to be added

Socio-technical capabilities to build agilty, adaptability and alignment during COVID 19 pandemic: evidence from Indian agriculture and fishing supply chains

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Purpose of this paper:

Focus of the research will be to understand the role of social and technical capabilities which enabled the farmers and fishermen to overcome the key constraints and demonstrate agility, adaptability and alignment as response to COVOD 19. The specific research questions addressed are as follows:

- How has the agricultural and fishing supply chains in India demonstrated agility, adaptability and alignment in response to COVID 19?
- What social and technical capabilities were needed to develop agility, adaptability and alignment (AAA)?

Design/methodology/approach:

News articles, local knowledge from social media, WhatsApp groups were used to identify farmers, farmer cooperatives or fishermen who were selling directly to customers during the pandemic. Search strings used for search of news articles were farmer or famer cooperatives or fishermen or fishermen cooperatives AND direct sales to consumers. Local farmers and fishermen were contacted and semi-structured interviews were conducted after translating the interview protocol in local languages. Interviews were transcribed and analysed to answer the research questions.

Findings:

The results showed that farmers and fishermen demonstrated agility in the form of direct sales of organic produce, selling immunity boosting crops, and by arranging special passes for goods movement between states.

Adaptability was observed in selling products through the local social network, engaging with customers, providing home delivery services, convincing the farmer producer organisation to enter into buy-back contracts with them and by planning for exports. Alignment was observed through collaboration with other small farmers, collaboration with agricultural institutions, farmer-producer organisations allowing farmers to use their retail space, collaboration with a school to use their school buses for logistics. The technical capabilities needed to develop agility, adaptability and alignment were customer engagement using social media, creating and using mobile application, where needed while the social capabilities include strength of the social network, tapping on customer goodwill, motivating employees and mental strength. The agility, adaptability and alignment not only ensured income for the farmers and fishermen, but also enhanced customer satisfaction and even generated alternate employment during crisis.

Value:

The value of this research lies in demonstrating how farmers and fishermen, who were considered to be most vulnerable to the pandemic because of potential lost sales and their lack of familiarity with technology, demonstrated agility, adaptability and alignment and in identifying the capabilities, which helped them in doing so.

Research limitations/implications:

The limitation of the research is that it is limited to 8 interviews. We contribute to the literature on AAA supply chains by studying it in the context of response of response by farmers and fishermen in India during the pandemic.

Practical implications:

We contribute to the literature on AAA supply chains by studying it in the context of response by farmers and fishermen in India during the pandemic. The results can help in developing a framework for improving agility, adaptability and alignment and in turn resilience of food supply chains in the face of future risk events.

A FRAMEWORK TO BUILD THE RESILIENCE OF SUPPLY CHAIN: A CASE STUDY OF JAVANESE TEA, INDONESIA

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Purpose of this paper:
Tea agribusiness in Indonesia considers as labour-intensive business. The existence of tea plantation also fosters the rural development both in economic and social aspect. Eighty percent of tea is produced in Java Island (Directorate General of Estate Crops, 2019). However, several problems regarding inefficiency of tea production centre and imbalance supply and demand in both global and domestic market gives pressure on the sustainability of tea agribusiness and its resilient supply chain. Basic design of a supply chain is a primary factor to determine its vulnerability and resilience (Smit and Wandel, 2006; Waters, 2007). By understanding the vulnerability of each actor in the supply chain, it helps to recognize their ability to efficiently response on the changing condition. Therefore, this study aims to understand the current condition and problems in tea supply chain and to develop the framework to build the resilience and sustainability of tea supply chain.

Design/methodology/approach:
This study is a case study approach focusing on identifying the role of each stakeholder in tea supply chain and determining the further action to build its resilience. The field survey was focused on three regency areas in Central Java Province. The convenience and snowballing sampling were used to gather data and information from respondents. The in-depth interview by using interview guideline was employed to enrich the information about the interaction among all stakeholders in the tea supply chain, the role of each stakeholders and their vulnerability. Total of 175 respondents, i.e. smallholders, middlemen, commercial tea plantations, tea processing unit, packers, traders, and related government officials, were participated. Business process analysis (IDEF0 model) were used in this study to comprehensively describe the current condition and help to develop the improvements action.

Findings:
This paper outlines that severe supply demand conditions in the domestic and global markets contribute greatly to the low benefits perceived by smallholders. The relationship among stakeholder in the Javanese supply chain is also explored through business process analysis. In addition, the livelihood of smallholder is highly depending on the tea farming and tea agribusiness. This condition increases the vulnerability of smallholder toward the changing condition and policy on commercial plantation and tea processing unit. However, the control from a big multinational trader has made the competitiveness of tea agribusiness very rigorous. The production costs in the commercial plantation are quite high with a yield of 20-22%. This paper also reveals the impact of COVID-19 on the resilience of smallholder, middleman and commercial plantation. The integrated framework in this paper describes five factors that should be considered to build the resilience of tea supply chain: vulnerability analysis, assets assessment, collaborative supply chain, control mechanism from government and stakeholder's outcome.

Value:
This paper provides an overview of the Javanese tea current distribution and its contribution to the community development. This paper also highlights the impact of COVID-19 for tea smallholder, middleman, and commercial plantation in general. This paper can be used as an evaluation material for all relevant parties i.e. government, smallholder, middleman and tea agribusiness to overcome the disruption that might occur and to prepare on building their resilience.

Research limitations/implications:
This research is more focus on upstream supply chain actors including smallholder, middleman, commercial plantation, tea processing unit and government officer. A major limitation in this research is the limited scope in Central Java Province. Further and more analysis might be needed in the future to develop the strategy for Indonesian tea to strengthen the domestic market and compete in the global market.

Practical implications:
The practical contribution of this research is to give understanding about the challenge of Javanese tea in domestic and global market. The integrated framework describes five factors that should be considered to build the resilience of tea supply chain. The finding of this research is also important for practitioner and policy maker to strengthen their role in the tea supply chain.

Conceptualising Supply Chain Resilience within Social Enterprises

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Purpose of this paper:

Despite growing in prominence and importance as an organisation for tackling pressing societal issues, nearly half of social enterprises (SEs) within the UK are less than 5 years old (42%), while 30% are 3 years old or younger (Social Enterprise UK, 2019). Given the emerging nature of the sector, coupled with the significant disruption caused by the COVID-19 pandemic and the positive correlation found between SE age and profit (Social Enterprise UK 2019), it is crucial that research be conducted into how SE-led supply chains (SESCs) can become resilient so to ensure their long-term survival.

Design/methodology/approach:

With the adoption of Network Theory as its theoretical lens, an in-depth review of SE and supply chain resilience (SCRes) literature was conducted so to build a conceptual model for resilience within SESCs. Specifically, literature illustrating SCRes concepts and secondary case studies on SEs were selected and analysed. A narrative methodological approach was adopted, opposed to systematic, due to the superseding study, from which this paper lends, focusing on an emerging topic that has largely gone overlooked. Thus, needing to draw from a range of literature besides that which informs this paper.

Findings:

Despite their contrasting for-profit and not-for-profit contexts respectively, there is considerable overlap evident between that found within the SCRes and SE literature. As within SCRes literature, SEs capitalise on collaboration to enhance visibility, risk management and understanding. Beyond this, they rely considerably on collaboration to access human resources, funding and planning and design support. Thus, it is concluded that concepts of SCRes hold within a SE context. However, unlike for-profit supply chains, the networks utilised by SESC are smaller in geographical scale, placing increased importance on location as a facilitator of collaboration, and therefore, resilience.

Value:

The primary contribution of this paper is the conceptualisation of SCRes within SESCs through extending well-established theories of SCRes literature beyond the for-profit context in which much of its research is conducted. A context in which humanitarian operations, such as social enterprises, do not fit. Therefore, addressing a gap within SCM research resulting from an underdeveloped focus on SEs. Furthermore, it is believed this paper will provide practical value to the SE sector as a whole.

Research limitations/implications:

This research was conducted as part of an ongoing wider study into resilience within social food supply chains and as such, all findings are pending empirical testing.

Practical implications:

It is believed that this paper will have practical implications for the structure of, and ties within SESCs through informing on that which can support the building of resilience capabilities.

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INDIGENOUS CULTURE AND CUSTOMARY PRACTICE IN BUILDING SUPPLY CHAIN RESILIENCE

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Purpose of the paper

This study explores how SMEs build their supply chain resilience based on the experience of Small Indigenous Batik Businesses (SIBBs) in Madura Island, Indonesia during the COVID 19 pandemic. It examines how SIBBs navigated the restrictions placed on their supply chain operations during the COVID-19 pandemic, with the view to shed light on the roles of indigenous artistry, traditional practices, beliefs systems, customs or social norms in helping SIBBs to manage these disruptions and build supply chain resilience.

Design/methodology/approach

This study uses a qualitative multiple case study approach. Through the help of our local contacts, we contacted eight SIBBs in Indonesia's Madura island and conducted in-depth, semi-structured interviews with members of the eight SIBB families over a period of three months (November 2020 – January 2021). Using the grounded theory approach, we systematically content analysed the interview transcripts, extracting themes from participants' responses and categorising them into constructs for interpretation and theory building.

Findings

Our findings indicate that like many businesses, the Batik supply chain of Madura – from procurement of raw materials to sales and distribution - has been severely hit by the COVID-19 pandemic. While the severity of the disruptions does vary between cases, almost all indicated that the pandemic is not totally destructive. The combination of indigenous Batik craftsmanship, local culture, customary practices, religious values and digital technology have enabled SIBBs to build supply chain resilience in unexpected ways, keeping their supply chain operations active despite the COVID-19 pandemic restrictions.

Value/Originality

This study is in response to the call for more studies to investigate the role of collaboration and culture to help SMEs, small indigenous business in particular, develop their supply chain resilience. It offers substantive insights on how SMEs' supply chain resilience is very often triggered and shaped by contextual factors, such as cultural values, geographical and industrial setting. From the theoretical perspective, the experience of the SIBBs in Madura, Indonesia suggests that local culture, religious beliefs and customary values, are key elements in building indigenous product supply chain resilience.

Practical implications

Findings from this study suggest that greater attention should be given to developing training programs to promote SIBBs' digital transformation to assist SMEs in Indonesia in general, and SIBBs in particular, to face the new challenges posed by the COVID-normal.

Key words: Supply chain resilience, COVID-19 pandemic, culture and customs, Batik making.

Supply Chains in COVID-19 Pandemic - Increasing Resilience through Digitalization and Sustainability

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Purpose of this paper:

The COVID-19 pandemic has shown the vulnerability of global supply chains. This conceptual paper gives feasible digital and sustainable solutions how to enhance resilience in global supply chains in the special case of COVID-19.

The pandemic has led to supply shortages, especially in the beginning in the distribution of face masks or shields. Single use of medical material due to hygienic reasons leads as consequence to growing waste. Most of it is not recyclable. For the contaminated material burning in special hospital waste incinerators is the only solution.

Another global challenge is the lack of qualified medical staff, especially doctors in those regions where a lot of COVID-19 patients need treatment or even artificial respiration.

This paper focusses on SDG 3 ("Good Health and Well-being") and on SDG 12 ("Responsible Consumption and Production").

Design/methodology/approach:

The research question is, how can we fight the virus through digital and sustainable solutions. The research methodology is a literature study.

Solutions are the integration of an efficient waste, energy and material management system, increased circular flows (lower resource consumption, less dependence of global markets) and fully automated processes.

Findings:

The integration of an appropriate waste management system is still difficult because of the existence of contaminated medical waste. The only solution is incineration under high temperatures. The thermal energy could be used for the hospital's heating. This leads to a circular flow in the energy system instead releasing the heat energy into the atmosphere. In general, environmentally friendly generation of energy is required for sustainable processes.

The use of robots to assist medical staff could help to alleviate the shortage of hospital staff. Especially for standardized workflows, such as the transport of material, robots could help to assist and save time. Furthermore, a robot can store the entire patient file, including all of the medication and past chronic diseases, better than every human specialist. Pattern recognition (through data analytics) to identify which patients could have high probabilities for needing artificial respiration could protect those better. An intelligent global distribution of medical material could provide goods there where they are most urgently needed. This guarantees a higher global material efficiency and also contributes achieving the goals defined by SDG 12.

Energy-efficient sensors, new standards in the field of wireless data transmission and networks that transmit data either on demand or after a defined time are necessary for the implementation of an intelligent supply chain and distribution network. This consumes less energy than conventional transmission networks, but has the same benefit.

Value:

Digital and sustainable solutions for challenges through COVID-19 are new research areas. The proposed solutions are all visionary. Further research is needed. Once implemented they could curb the pandemic tremendously and in consequence serve the common good, especially by strengthening global supply chains. At the same time some of the 17 goals of the SDGs (Sustainable Development Goals), established in September 2015 by the

United Nations, are met. The SDGs are an action plan and should be fulfilled by the year 2030.

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Conceptualising resilient food supply chains: the nexus between data, strategy, and time

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Purpose of this paper:

This research aims to explore the potential of data and data driven technologies in achieving greater control in the food supply chain and also in creating a data rich relationship between customers and suppliers. A plethora of data (both open and closed) already exists across the various nodes in the supply chain, with larger retailers retaining some individual consumer data within the food supply chain. Government reports, such as Elliott (2014) propose the need for data sharing across food chains to create better resilience and to retain food integrity. The Food standards agency proposes the need to create a better consumer understanding of the origin of food in the chain, and clearer metrics around food authenticity, criminality, safety, and sustainability (FSA, 2016). However, SME's within the food supply chains do not possess the ability, funds and networks to integrate, interpret and utilise supply chain data to manage their operations effectively and efficiently. The convergence of a range of technologies (such as sensor-based technologies, wearables, advances in human genomics and advanced data analytics) now offer a platform to further enhance these experiences by addressing knowledge deficits (e.g. genomic, food requirements), time and budgetary constraints. During the COVID-19 pandemic food supply chains have had to rely on flexibility, emergent supply chain strategies, and robust information flows to keep the shelves sticked. This leads to a requirement for understanding the nexus between data, supply chain strategy, and the time window for resilience (short or long) to tackle food supply disruption. Recent articles discuss several strategies, of which reshoring or local supply chains is a popular discussion (Garnet, et. al. 2020; OECD, 2020; Deloitte, 2020)

Design/methodology/approach

This work utilises a dual approach. The first phase involves a review of the literature within academic journals and professional publications. This review focuses on challenges within food supply chains, data proliferation and the use of data to manage supply chains. The second phase involves an analysis of case studies using data available through secondary data sources. This qualitative data is analysed using a 'thematic analysis' method. The literature review and thematic analysis provides a conceptual framework to create supply chain strategy for resilient food supply chains using the links between data sources and time of recovery.

Findings:

The research is currently undergoing. It is envisaged that the research will enable three important results:

1. Provide a state-of-art perspective on current use of data within food supply chains

2. Provide an understanding of how data will help inform resilient food supply chain strategy

3. Provide a conceptual framework using the aspects of data use, recovery time frames, and strategy

Value:

The paper provides a number of contributions. It provides an insight into an upcoming research domain namely- use of data to manage food supply chains within uncertain scenraios. It provides an overview of data technologies and implementation case studies. The paper will provide value to both academics and practitioners.

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The Complexities of Metering in the Nigeria Electricity Supply Industry.

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Purpose of the paper:

External uncertainties, information inadequacy, and rigid policies have continued to cripple strategic metering initiatives in the Nigeria Electricity Supply Industry, contributing to the low financial performance of electricity distribution utilities. This challenge is adduced to project complexities involved in the supply, acquisition, installation, maintenance, and disposal of meters. With the implementation of three strategic metering initiatives after privatization in November 2013, no significant progress has been recorded in closing the metering gap of six million unmetered customers. Besides, this gap will continue to grow due to the demand for electricity, urbanization, and growth in rural settlements. Notably, the regulator has enacted different initiatives with a genuine course of closing the gap. However, the impact of the initiatives has not been felt by electricity consumers. In addressing this problem, this research will review the complex interplays in deploying a sustainable metering strategy and the sources of uncertainties that have undermined successive policies to close Nigeria's metering gap. The study will develop a framework for the Nigeria Electricity Supply Industry for sustainable metering programs focusing on risks and uncertainties and recommend innovative approaches that will improve the total cost of ownership of the meters, which has also been a huge challenge for the industry players due to resources required for metering investment. Meters represent the most viable and accountable device for energy consumption, providing payment assurance to the electric utilities. Therefore, addressing the challenge of properly rolling out and implementing a sustainable metering program in Nigeria will positively impact the distribution utilities' financial performance.

Design/methodology/approach:

The authors reviewed the context of complexity, risk, and uncertainty in supply networks and metering strategies applied in various countries sharing a similar social-economic environment with Nigeria. Past program implementation performance reports from the Nigeria Electricity Supply Industry will be reviewed to identify the distribution utilities implementation challenges. A proposition will be developed from this interdisciplinary review for a sustainable metering framework.

Findings:

The distribution utilities find it extremely difficult to provide meters due to a shortage of resources as this is a capital-intensive undertaking. Also, information dissemination about new metering initiatives is poor. This cuts across the various stakeholders and the public with varied opinions on getting a meter installed for the end-user. There are also other external uncertainties derailing the success of these metering initiatives, such as fiscal constraints, local manufacturing capability, and a weak market structure.

Value:

The proposed framework will focus on risks and uncertainties affecting industry stakeholders such as policymakers, suppliers, distribution utilities, and consumers. A recommendation on risk avoidance and mitigating approaches that will stimulate active participation will be developed. The framework will bring about a more efficient and effective process, leveraging relationships and connections in the supply network, which can be applied in other countries with similar experiences. The paper will be of value to the players in the electricity industry.

Research limitations:

Empirical validation of the proposed framework

Practical implications:

The practical implications are managers can begin to adequately identify critical nodes, structures, relationship dynamics involved in the metering supply process. They can also measure and quantify the process flow for better planning towards an improved system.

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SECTION 5 – SUSTAINABILITY

The role of Maker Spaces in developing responsive local supply chains

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Purpose of this paper:

This paper describes the role of maker spaces in developing local supply chains as a means to support SMEs in responding to local production opportunities

Methodology:

The paper highlights three case studies of maker spaces, in Berlin, Birmingham and Lisbon. Maker spaces are places where people with common interests work on projects while sharing ideas, equipment and knowledge. The development of these spaces has emerged from the Fab Lab movement and is now growing as a key part of city innovation eco systems for SMEs (Markussen, A. 1996). This growth in maker spaces reflects the need for collaboration at the local level as well as demographic and societal changes which encourage collaboration (Myers, K.K and Sadaghiani, K. 2010).

The three case studies represent a cross section of different maker spaces from the Berlin makerspace movement (including the development of digital hackathons), STEAM house in Birmingham (a maker space linked to a University) and the maker space network in Lisbon.

The authors have direct experience of these cases and are engaged in ongoing developmental activity with them.

Findings:

Maker spaces can provide a mechanism in the new product development lifecycle for the prototyping of new ideas based on sector and city challenges. They favour a design led thinking approach

within an open innovation environment (Chesbrough, H and Bogers, M. 2014) and add an important dynamic to the infrastructure supporting SMEs.

The spaces began as a grassroots phenomenon using local insights and kit such as 3d printing, which now connects with mainstream innovation and commercialisation systems. Increasingly, this represents the use of Artificial Reality (AR) and Virtual Reality (VR) technologies.

The maker spaces act as a catalyst for interdisciplinary working and as such, allow for greater diversity in participation from SMEs, large companies, science parks, universities and citizens.

Value:

The case studies give insights to policy makers as to how maker spaces can evolve and the different roles they can play in building resilience in local supply chains.

Practical examples are discussed as well as the underpinning culture and approach embodied in these spaces.

The paper shows that from a position of community bottom-up approaches maker spaces are now becoming important actors in local innovation eco systems.

They represent a way for SMEs to share resources and to tackle new opportunities collaboratively.

As local sourcing and re -shoring of production increases as a phenomenon, maker spaces can play an important part in connecting these opportunities to local businesses.

Practical implications:

The paper indicates steps to be taken by local stakeholders to enable them to support maker spaces.

It shows the philosophy required to grow these spaces, spatial considerations and suggested technologies and gives insights into future trends.

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Mobility (service) innovation to increase resilience in smart sustainable cities.

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Abstract Mobility (service) innovation are important to the resilience of smart sustainable cities. The cooperative and collaborative engineering of mobility innovation is a participative process and requires joint activities of both stakeholder groups: public and private. While citizens are encouraged to pro-actively report data and announce their needs, government and decision makers are encouraged to transform the data and reported needs into service requirements. Currently, both groups lack a participation system to collaboratively create innovation and to cooperatively develop the Mobility of the Future. Within this scholarly article, we not only analyze the citizens' requirements but also evaluate their need towards innovation and resilience in smart sustainable cities. We propose a data collector and data visualizer app to co-create joint mobility innovation and increase system resilience. This app acts as interface between mobility stakeholder groups and enables participative mobility innovation and resilience engineering.

Keywords: • Mobility of the Future • Innovation & Resilience • Sustainability • Melinda •

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A TOOL TO FACILITATE PARTICIPATORY MODELLING OF URBAN LOGISTICS

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PURPOSE:

Urban logistics is a complex multi-stakeholder and multi-criteria decision situation. This paper presents a tool made for a case study wherein a city is investigating different options for heavy commercial vehicles to traverse the city and thereby how much pollution emissions they produce. In the process, participatory modelling is adopted as the method for research and development of the case. The participatory modelling approach facilitate production of data by individuals and ensure that a participant's input is processed in a transparent manner [1]. Communication, hence, becomes a key aspect of participatory modelling [2]. Communication can be made more concrete if it is based on quantitative data. Also, research has shown that participatory modelling based on a relevant tool engages stakeholders more as compared to stakeholders with no tool used in a discussion [3]. We, in this paper, discuss a case study of participatory modelling in which we make the communication better and aid in the process of decision-making by providing stakeholders with a prototype of a tool based on the SUMO software.

DESIGN/METHODOLOGY/APPROACH:

The tool was developed on the open-source software SUMO (Simulation of Urban Mobility - https://www.eclipse.org/sumo/). A GUI python program was written that takes as input the SUMO configuration files and outputs the result as shown in Figure 1. The SUMO simulation, in turn, takes OpenStreetMap and Origin/Destination matrix as input.

FINDINGS:

It was determined that participatory modelling can be made more interactive and easier to engage stakeholders in a discussion with a help of a relevant tool. Furthermore, it was found that the ability to quantify outcomes significantly increase the pace of the discussion and interests of the stakeholders together with the quality of the discussion.

VALUE:

The value of this work lies in facilitating discussions among stakeholders and aiding in the process of decision-making. This exempts all stakeholders, including local experts, domain experts and experts from non-technical backgrounds to be able to run simulations without necessarily having a deep understanding of the simulation software, that is, SUMO in this case.

RESEARCH LIMITATION/IMPLICATIONS:

The work presented here is under development. The research is currently in the phase of developing the usability of the tool and determine how it can be further improved. The tool has currently been used for single city case study and it is planned to be extended to other case studies.

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ENHANCING SUSTAINABLE PERFORMANCE THROUGH STAKEHOLDER COORDINATION AND COLLABORATION: EVIDENCE FROM BANGLADESHI GARMENT INDUSTRY

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Purpose:

The relationship between companies and stakeholders is crucial due to collaboration and shared economic goal issues. For the garment industry, fragmented stakeholders such as owners, management, legislative bodies, and customers are more concerned than ever about the implementation of sustainability practices. This is leading companies to introduce different types of collaboration practices into their supply chain contracts, like- internal and external knowledge sharing, mutual understanding, and strategic collaboration, with the aim of enhancing their sustainability performances. While the extant literature on supply chains acknowledges this trend, more insights on the concept of 'stakeholder collaboration' are needed, including and its consequences in the garments industry. The purpose of this paper is to investigate this concept and explore how such requirements may improve sustainability performance in the Bangladeshi garment industry.

Methodology:

Qualitative methodology was adopted by the study and data were collected through semi-structured interviews from the Bangladeshi garment industry. Later, thematic analysis was used to identify the relevant phenomenon.

Findings:

Several factors were found to be influencing stakeholders' collaboration. This included mutual coordination, sharing knowledge and resources, lean practices, internal audit, buyers' environmental requirements for factory standardization, the complexity of implementing the requirements, and the use of stakeholder-specific frameworks. The finding revealed that stakeholder collaboration has a positive impact on garments industry's sustainable performance.

Value/Originality:

This research establishes evidence for the relatively new phenomenon of "stakeholder collaboration" and develops a framework to demonstrate the relationships among the critical determinants relevant to this phenomenon.

Research Implications:

The case studies are limited to the Bangladeshi garments industry. Given that stakeholder collaboration may vary across different countries and industries, the data may not reflect all the possible variations in stakeholder collaboration requirements. For practical implications, the new insights proposed by this research can guide firms to further understand how stakeholder collaboration can enhance the sustainable practices of the garments supply chain.

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Exploring challenges and opportunities for glocal value creation in reverse textile supply chains

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Purpose of this paper:

In the very centre of efforts taken towards circular economy is to establish effective and efficient reverse supply chain practices (Batista et al., 2018). For optimal value recovery, reverse supply chains must be designed in such a way that both local and global effectiveness and efficiency are enhanced. In a textile industry context this design has shown to be challenging, as there is often a trade-off between attaining volume-based efficiency in global reverse supply chains on the one hand, and maximising local value opportunities on the other. However, if successfully designed, a combined global and local (i.e. glocal) perspective may contain new opportunities for enhanced value creation (Sandberg et al., 2018; Jia et al., 2020). The purpose of this paper is to further explore such glocal challenges and opportunities in reverse textile supply chains.

Design/methodology/approach:

Based on a literature review, the paper identifies a number of glocal challenges and opportunities for enhanced value creation. A conceptual framework is constructed.

Findings:

The findings reveal five challenges, described as lack of (1) alignment between reverse supply chain activities, (2) alignment between clothing design and reverse supply chain activities, (3) holistic, concurrent supply chain development, (4) regulations, and (5) knowledge. The analysis provides two principal types of glocal challenges in reverse textile supply chains; conflict challenges respectively consolidation challenges. Opportunities to tackle these challenges revolve around (1) New global players, (2) Increased collaboration, (3) new technology, and (4) joint regulations and standardisation.

Value:

In contrast to existing research that has been mainly focused around local (national) value creation efforts, this research offers insights into how global and local interests in these supply chains can be combined. The developed framework targets challenges, as well as opportunities for how to overcome these challenges, at a systemic level, beyond the borders of a single company or supply chain.

Research limitations/implications (if applicable):

The research is limited to the textile industry.

Practical implications (if applicable):

The effective and efficient design of circular textile supply chain plays is vital for improving environmental performance but offers also opportunities for economic value creation.

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ALIGNING GREEN SUPPLY CHAIN MANAGMENT WITH PRODUCT TYPES

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Purpose of this paper:
This study aims to explore *how* green supply chain management (GSCM) practices can be implemented more efficiently and effectively in the rapidly changing market. We attempt to identify dynamic transformation across a company's internal and external green supply chain operations with green product development on different product markets.

Methodology:
This study adopts an exploratory case study, investigated one of the largest multinational ICT companies, an early adopter of GSCM in China that leads the domestic consumer electronics market environmental reform. We examined company's GSCM transformation across its four key product lines. Eleven in-depth interviews were conducted with numerous onsite visits, online meetings and follow-up phone calls for qualitative data collection. We applied thematic coding analysis with Nvivo software followed by a thorough within-case and cross-case comparison analysis.

Findings:
The findings of this study propose a strategic taxonomy of GSCM on different products. For generic products, improving volume efficiency and reducing wastage on internal operations and supply chain cost is the priority for GSCM. Among them, durable generic products can improve use life efficiency through building long-term customer relationships and service flexibility while extend (green) product life. For fast-consuming generic products, business can improve close-loop resource efficiency via expansion of operations to include internal volume recycling.

For premium niche products, improving eco-design and building dynamic relationships with supply chain stakeholders for value creation is the key for GSCM. Among them, fast fashionable niche products can improve existing value via adapting product design and enhancing process integration and total system responsiveness for underexploited market expansion, e.g., second-hand market. For durable premium products, business can create green value via radically product design innovation and system upgrade for new market development. Key operational and relationship capability elements are further identified for each strategy in findings.

Value:
The study contributes to knowledge of GSCM and competitive strategies. It enriches the GSCM literature by specifying the linkage between various product supply chains and green approaches, in terms of internal operations, external operations and eco-design management.

Green Logistics Management (GLM): the relationship between internal motives and GLM performance

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Purpose of the paper:

The purpose of this paper is to analyze the relationship between the internal motive of GLM adoption and GLM performance.

Design/methodology/approach:

Hypotheses have been constructed by comprehensively and systematically reviewing the extant literature in GLM discipline. In order to test hypotheses, this research will employ a questionnaire survey to the managers in logistics companies in South Korea. The results of the hypotheses test will be confirmed with factor analysis, structural equation model analysis, and bootstrapping analysis.

Findings:

So far, we have identified there has been a lack of academic attention given to the relationship between those variables aforementioned as much of previous work in GLM discipline tended to work on external factors affecting GLM performances. As this is a working paper, we hope find whether the internal motives for GLM adoption could exert a significant impact on GLM performance. This research could also be extended to discover that the improvement in GLM performance can increase the satisfaction with green certification.

Value:

First, our paper examines the internal motives of adopting GLM and its influence on GLM performance through empirical analysis. Second, the paper can provide a new insight for the practitioners in the logistics industry relevant field. Largely prompted by peer pressure from other competitors and external regulatory bodies such as government and NGOs, internally motivated voluntary cultivated motives for GLM adoption can be important above all for the improvement of GLM performance for the logistics companies. Third, a valuable message for the logistics industry can be generated if our research extends to see whether the improvement in GLM performance can increase the satisfaction with green certification.

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Urban production logistics planning considering environmental sustainability perspectives: Turku city case

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Purpose:

The EU policies (https://www.sciencedirect.com/topics/social-sciences/eu-policy) in the Baltic Sea Region (BSR) focusses on sustainable energy development (https://www.sciencedirect.com/topics/engineering/sustainable-energy-development) through integration of greener ports [1, 2]. Inline with the EU goals for BSR, the purpose of this paper is to present a generic model building approach to understand and quantify the aspects of environmental sustainability in terms of vehicular emissions in the port regions. One pertinent way of realizing the quantification of pollutant emissions is based on the engine models of vehicles. For this, simulation was chosen as the mode of study as we described the characteristics of both as-is and to-be models. According to existing literature, SUMO software is the best fit as the modelling tool when it comes to modelling environmental sustainability [3].

Design/methodology/approach:

A case study based approach was chosen for the research design of this work. First, two scenarios were drawn based on the publicly available data for Turku port region (https://www.portofturku.fi/en/ports-operations/newsroom/statistics/). Scenario 1 consists of heavy commercial vehicles with diesel engines of type Euro5 and scenario 2 has diesel engines of type Euro6. Simulations were run in SUMO (Simulation of Urban Mobility; --- https://www.eclipse.org/sumo/) a software and comparisons were made in terms of pollutants emissions CO, CO2, NOx, PMx, HC. Map of Turku was imported in SUMO using OpenStreetMap (https://www.openstreetmap.org/) and routes available for trucks to traverse in the city were collected from the publicly available data.

Findings:

A comparison of the two scenarios indicates that the highest reduction of emissions related to loading and unloading of the ferries vary depending on not only the type of engine but also the time of the day for the activities.

Value:

The value of this work lies in quantifying and reporting environmental sustainability estimates in the port region of Turku where passenger cars and heavy commercial vehicles flows produce emissions. This work is the first step in quantifying the pollutant emissions and based on it rectifying action will be decided for heavy commercial vehicles in the area.

Research limitations/implications:

The research work done so far is based on the daily averages of the vehicles and the capacity of ferries as provided in the publicly available data. However, with higher fidelity data the quality and implications of the simulation results can be made better.

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Strategic opportunities for product-agnostic decentralised remanufacturing

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Purpose of this paper:

Remanufacturing offers the potential to make a significant contribution to the Circular Economy. Through remanufacturing, worn and broken products are reinstated to functional service, in the same condition and with an equivalent warranty to a newly manufactured item. Remanufacturing is being increasingly employed in a wide range of industrial sectors, though notably most remanufacturing facilities are intended for specific products (or product groups). Whilst this specialisation of a dedicated remanufacturing facility may support process efficiencies and scale economies, there are downsides too. By tending towards a 'centralised' model of remanufacturing, whereby failed and failing products are returned by customers to a single geographic location, there is a significant reverse-logistics requirement for the supply chain, and a corresponding environmental penalty in return transportation.

This paper examines several strategic opportunities for remanufacturing. We consider the benefits, challenges, and critical success factors for remanufacturing, and explore how these are impacted by choices in network design. Further, we examine how decentralized facilities may be able to counteract lost economies of scale with new economies of scope through product-agnostic remanufacturing that allows increased variety in products being remanufactured.

Design/methodology/approach:

This paper provides a detailed review of the published literature on remanufacturing, and by making linkage with theory in the strategic management of supply chains and operations, provides a timely extension to the remanufacturing concept.

Findings:

This literature-based piece provides a detailed exploration of the opportunities and critical success factors for remanufacturing, subsequently introducing the potential for product-agnostic remanufacturing. We propose several opportunities to fundamentally change the approach taken to network design for remanufacturing and highlight the potential implications for research and practice.

Value:

Whilst remanufacturing has gained significant interest in logistics and operations management research and practice, the critical success factors are poorly understood, and there has been little emphasis on product-agnostic facilities. Our work therefore makes an initial contribution to this research gap and provides a valuable agenda for future research.

Research limitations/implications:

This working paper presents the theoretical principles of a decentralised remanufacturing approach that is product-agnostic. Its findings are derived from literature, and we do not seek to validate or test the propositions within this initial study.

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A readiness assessment of 3D printing in the construction industry with a focus on supply chain aspects

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Purpose of this paper:

To provide an initial analysis of growth prospects of the use of 3D printing in the construction industry (3DCP) in particular to assess potential markets and model key processes and stakeholders in the required supply chains.

Design/methodology/approach:

Using the German market as an example, we investigated the market for 3DCP as well as the existing challenges by the traditional construction industry in meeting housing demand.

Findings:

By analysing the current market and future market requirements, this study revealed that the adoption of 3D printing in the housing construction industry could offer considerable benefits for both construction companies and end-users, while at the same time improving sustainability, affordability and productivity. More specifically, the adoption of 3DCP could offer high personalization levels, automation, and cost-effectiveness, due to a shorter supply chains.

Value:

Building upon previous work by the authors in the area of 3D printing services (Rogers et al, 2016) and insights from the survey, three categories of 3DCP services are proposed for the first time in this way.

Research limitations/implications: The three proposed models of 3DCP supply chains should be considered dynamic, owing to market fluctuations and technological developments, requiring testing via specific business cases.

Practical implications:

The originality lies in providing recommendations on overcoming the recognized limitations of 3DCP as a pathway to developing viable business models in the construction industry and providing initial indications as to how 3DCP can contribute to the UN's Sustainable Development Goals (e.g. 12: Ensure Sustainable Consumption and Production Patterns).

Keywords:

Keywords: 3D Printed Housing, Additive Manufacturing, Construction Industry, Sustainable Business Models.

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A SYSTEMATIC LITERATURE REVIEW OF SUSTAINABLE PACKAGING IN SUPPLY CHAIN MANAGEMENT

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ABSTRACT

Purpose of this paper:
Sustainable packaging has increasingly become a major concern for consumers, governments, and businesses, who have raised the importance of reducing packaging waste, which has gained renewed importance and awareness due in part to the recent increase in use of disposables and single-use plastics as a side consequence of COVID-19. Rising consumer awareness of environmental protection and social impacts are resulting in added pressure on industries to implement sustainable packaging initiatives in efforts to minimise waste and maximise product value within the supply chain, in a strive towards sustainability and circular economy, which has now become the focus for actors and stakeholders that work towards achieving sustainability. This exploratory study has utilised quantitative analysis to deliver a systematic literature review of published journal papers in SCOPUS and WoS through time until 2020 with the aim to present a comprehensive accord of research focus conducted in the sustainable packaging domain within the scope of supply chain management (SPSCM).

Design/methodology/approach:
This research was conducted with the data mining software, NetMiner 4, utilising three analytical tools of statistical analysis, keyword network analysis, and topic analysis. The research also utilised qualitative method of in-depth interviews to validate the analysis results.

Findings:
The research findings indicate that SPSCM research had been previously extremely limited, and has increased significantly since 2013, with research trends becoming increasingly diversified and gradually aligning with the concept of circular economy, as sustainable packaging is gaining significant importance. The keyword frequency analysis reveals the following highest occurring keywords in TF: life cycle; environmental impact; consumer; transportation; and production. The highest occurring keywords in TF-IDF: production; transportation; consumer; food; and environmental impact. Topic modelling revealed the following six topics: consumer behaviour; environmental pollution; circular economy; waste management; resource conservation; and operational management, with the topics of circular economy and waste management gaining attention, as sustainable packaging is gaining importance due to trade patterns of global supply chains, the emergence of e-commerce, and raised consumer awareness.

Value:
This study can be utilised as a foundation for further research development.

SECTION 6 – TRANSPORTATION, DISTRIBUTION & HUMANITARIAN LOGISTICS

Reflecting on the resilience of rail freight traffic flows in South East Wales

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Purpose

Recent economic trends have heightened awareness of the concept of economic resilience, both at a national and regional level. Indeed, there is an increasing focus upon regional economic resilience by policy makers. However, the focus often does not consider logistics, yet this not only plays a significant role supporting manufacturing but is also a major industry in its own right.

Therefore, the aim of this paper is to evaluate economic resilience for the rail freight industry, with a focus on South East Wales in the UK. About 10% of all rail freight in the UK passes through this area, with both bulk and intermodal traffic flows. Through the use of innovative data sets, a longitudinal study covering a five year period evaluates the resilience of this industry.

Research approach

Data has been largely collected from a wide range of secondary sources. Rail freight activity has been formulated from publicly available real time data on railway activities. This is supplemented by policy documents, governmental statistics, academic journal papers and the trade and popular press.

Findings and originality – The paper reflects upon the resilience of the rail freight industry in South East Wales. Some services have reduced during the five year period, often due to macro level factors outside the control of the sector, such as the end of coal-fired power generation. However, new flows have also emerged in sectors offering longer term opportunities. Potential conflicts between passenger and freight based modes are also identified.

Research impact

The application of concepts whose origins are in economic geography, enables the development of novel approaches enabling an evaluation of the resilience of the rail freight industry to be made. This will facilitate the identification of factors that may enhance and inhibit the development of these services in the future.

Practical impact

There has been limited consideration of resilience in the rail freight industry at a macro or policy making level. By applying concepts commonly used in economic geography, an evaluation of resilience can be made, identifying factors that may enhance and inhibit this development. Although regionally focused, this reflects trends in policy making within the UK and elsewhere today.

Impact of COVID-19 on logistics sector companies

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Purpose of this paper:

The scale and measure of the impact of the COVID-19 on economic development has been a popular topic in the literature. The global pandemic has posed challenges to the supply chains and logistics in many countries, causing delays and disrupting supply chains and decreasing the volume of logistics flows. To ensure economic growth in the future, it is essential to acknowledge the impact the COVID-19 and in order to increase the accuracy of anticipating changes during widespread pandemic. In this study the linkage between economic development and the COVID-19 estimated and real impact is illustrated in a case study comparison between the Finnish and German logistic companies' viewpoints. The study shows how the international COVID-19 pandemic has affected to logistics organization perceptions on the changes in operational environment and continuity of business.

Design/methodology/approach:

This study aims to explore the impact of COVID-19 to logistics sector companies before and during the crisis. The empirical part of the study relies on panel data from logistics companies. The panel participants were logistics sector actors and the data was collected through a questionnaire Numerous sources found from the literature are used to gain a holistic understanding of the attributes and impact of change in the logistics field.

Findings:

This study provides an important, yet sparsely addressed viewpoint to the supply chain management literature by illustrating the changes caused be a widespread pandemic can cause to the logistics sector companies. Furthermore, the findings illustrate how different roles in supply chain actors perceived the COVID-19 in their operations, before and during the pandemic. The findings of the paper illustrate how drastic uncertainty and changes in the operational environment is seen in the logistics organizations in Finland. The findings suggest that increased uncertainty and changes in the operational environment can cause significant drop in expectations of the business development in the logistics sector.

Value/Originality:

This paper contributes to the supply chain management and logistics literature with insights into how widespread pandemic is perceived in different roles of the supply chain as well as in different countries where the pandemic has spread in different pace. Analysing the differences between the expected and realized impact from the business environment can give valuable information for academics and managers in the field, and thus give insights to improve the planning and decision making in logistics field during a global pandemic.

Practical implications (if applicable):

The study helps to understand the nature and dynamics of perceptions in the logistics field under uncertainty and how global pandemic impacts the the views of actors in different position of the supply chain. The presented view offers insights how the expected and realized changes in the business environment differ and gives insights to managers how the well the changes in the business environment can be anticipated.

Air cargo industry after covid-19: A research framework

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ABSTRACT

PURPOSE
The air cargo industry has benefited greatly from the globalization process in the past thirty years, experiencing robust growth. However, the recent Covid-19 pandemic has stagnated the industry, casting much doubt on its future. Will it be brought down by the deep recession of the passenger industry? What paradigm shifts can one expect from the industry? This study is thus initiated to explore the status of the industry and proposes a research framework for an in-depth investigation of a possible re-think in airfreight operations.

DESIGN/METHODOLOGY/APPROACH
We apply both a desk scan and a preliminary interview study of several Turkish air cargo customers before the pandemic to understand the status of the industry. As the pandemic is still unfolding and evolving, updated industry-wise statistics are used to derive our propositions.

FINDINGS
We posit the pandemic to be a catalyst for an industry paradigm shift, which will transform cargo movements from one that is largely dependent on the capacity of the passenger airlines to a network closely integrating both cargo and passenger flights. Dynamic pricing for cargo capacity will also be used more to charge customers based on their utilities. In response, freight forwarders then have to extend their industry and regional coverage for resilience and cost-advantage.

VALUE
This study sheds light on the effect of Covid-19 on the air cargo industry, providing a new example on how an external "grey swan" event has transformed a fast-growing industry unexpectedly.

RESEARCH LIMITATIONS/IMPLICATIONS (IF APPLICABLE)
The research propositions would need empirical validation and field data input to enhance the understanding on the possible paradigm shift in the industry.

PRACTICAL IMPLICATIONS (IF APPLICABLE)
The predicted paradigm shift, if verified, would significantly alter the industry landscape, presenting both challenges and opportunities for the players in the industry during and after the pandemic, much more than what a normal economic recession would.

KEYWORDS: Air cargo, aviation, Covid-19, competition strategy, transformation, innovation

Baggage policy design using a newsvendor setup

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Although airline revenue management is an established field of research, most of the studies focus on the passenger side. Higher operating costs and fluctuating passenger demand make it difficult for the industry to increase the net profit per passenger across the globe. The first decade of the 21st century was challenging for the industry due to the economic disruption and sudden surge in jet fuel price. To maintain the revenue flow and remain competitive in the transportation business, airline operators started looking for different revenue generation sources. Cargo services and unbundling ancillary services from regular airfare were the most significant contributions in augmenting the airline industry's profit. Among all ancillary services, baggage fees collected from passengers showed a promising revenue source for airlines over the years. Studies have shown that baggage is considered equivalent to cargo where both volume and weight are decisive factors for an aircraft's belly capacity. Most airlines mention a pricing structure in their baggage policy wherein they maintain a free limit for baggage weight or pieces. As the customer demand is uncertain, they face a challenge in deciding each service class's baggage allowance. A few studies have focused on the pricing side of the baggage policy, whereas the allowance decision remains untouched in the literature. This paper aims to answer the optimal free allowance decision for baggage where demand, in addition to the exogenous uncertainty, has an endogenous component of baggage allowance. There is a direct effect of free allowance on baggage demand. i.e., a higher allowance stimulates the demand. This phenomenon can be captured using the concept of first-order stochastic dominance, and we assume that the likelihood of getting a lower demand is less when the allowance levels are higher for both weight and volume. We consider the problem as a newsvendor model where the monopolist airline vendor faces a random demand of baggage weight and volume from the customer. The solution to the model gives the allowance as the decision variable. This research paves the way to a new direction in baggage policy, taking the cost factors into account. Based on the model, airlines may be able to increase the revenue from baggage services alone and make the correct decision in policymaking.

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HUMANITARIAN LOGISTICS: A SYSTEMATIC LITERATURE REVIEW

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Purpose of this paper:
This study aims to conduct a systematic literature review to understand the research trend, identify areas needing further improvements and propose future study in the humanitarian logistics area.

Design/methodology/approach:
Using Netminer 4.0, bibliometric analysis, keyword frequency analysis, keyword network analysis and topic modelling analysis were conducted.

Findings:
As a result, it was discovered that after the middle of 2010s, the amount of studies related to HL(Humanitarian Logistics) surged. Also, it was revealed that the main issues in HL were changing continuously. Keyword frequency analysis and keyword network analysis show that from 2005 to 2009, establishing the identity of HL and disaster response, recover and preparation were the main issues in that period. It was discovered that transportation and education from 2010 to 2014, and coordination and provision from 2015 to 2019 were mainly studied in HL. After topic modelling analysis, nine topics (coordination, preparation, sustainable development, stakeholders, recovery, facilities location, emergent response, transportation, supplying and sourcing) were extracted. Among them "facilities location" was on the 1st rank and "preparation, recovery, emergent response, stakeholders" were cold topics and "coordination, facilities location, supplying and sourcing" were hot topics.

Value:
There were no previous literature review using network analysis and topic modelling in HL so far. Thus, this study can suggest objective and quantitative literature review using a new method and will be helpful to provide the future research direction in HL.

Modelling Eligibility for Humanitarian Aid Distribution: The Case of Syrian Refugees in Turkey

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PURPOSE

In the field of humanitarian logistics, humanitarian supply chain management responding to refugees is an important but understudied topic. This study is thus initiated to explore the aid distribution problem, a critical aspect of humanitarian aid operations. Taking the largest humanitarian disaster of 21st century, Syrian civil war, as the research background, we have solved an aid distribution problem for Syrian refugees resided in Turkey.

DESIGN/METHODOLOGY/APPROACH

We have developed a mathematical programming model to optimize the aid distribution. Based on beneficiary data collected by Turkish government agencies and the criteria used by Red Crescent Card, an aid distribution card issued by Turkish Red Crescent, we develop appropriate eligibility criteria thereby. The model takes eligibility criteria, cash, and budget as inputs, and satisfied needs, distributed amounts, and number of beneficiaries reached as outputs.

FINDINGS

Applying the model to five scenarios of 30 families, 130 people, and a budget of 10,000 TL as samples of actual refugee situation in the field with their characteristics varied, we find that our model is effective in practice, reaching at least 70% of families and a minimum of 90 beneficiaries. Moreover, there are only two binding criteria for most cases even though total four eligibility criteria are used as inputs.

VALUE

This study has developed an optimization model for a fair and effective aid distribution for Syrian refugees in Turkey. The model is versatile, applicable to different settings and allows for multiple objectives.

RESEARCH LIMITATIONS/IMPLICATIONS (IF APPLICABLE)

The source of eligibility criteria is limited. A rigorous empirical validation is needed. Further study can explore in-kind aids as well as the timing effect of aid distributions.

PRACTICAL IMPLICATIONS (IF APPLICABLE)

The model may help aid agencies to make more informed decisions in their aid distributions. The model allows them to test various scenarios to balance multiple objectives for fairer and more effective supports to beneficiaries in needs.

A QUALITATIVE SYSTEM DYNAMICS MODEL FOR HUMANITARIAN SUPPLY CHAIN RESILIENCE

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Purpose

Humanitarian supply chains (HSCs) face an unprecedented level of socioeconomic and sociopolitical challenges in addition to the uncertainty of global crises such as the recent COVID-19 pandemic. The purpose of this paper is to review key drivers of humanitarian supply chain resilience along the three main HSCs resilient phases (i.e., readiness, response, recovery), and to propose a system dynamic model that links operational relief resources (e.g., employees, donations, inventory) to drivers of HSC resilience.

Design/methodology/approach

This paper takes a qualitative approach from the system dynamics modeling discipline through a two-phased research design. The first phase is a review of factors affecting HSCs resilience performance under three main HSCs resilient phases. The second phase involves the development of a causal loop model illustrating the interdependencies between performance factors based on a critical literature review. Themes and concepts across qualitative data were synthesized and linked with associated variables to create interdependencies.

Findings

The proposed causal loop model demonstrates the systemic interdependencies and feedback loops between the HSCs resiliency factors that influence HSCs resilience. It is a first step in the development of system dynamics models for the assessment of HSCs resilience.

Originality/value

This paper provides insight into the conceptual understanding of causal relationships of resilience factors in humanitarian relief. It allows for a systemic level of understanding of supply chain resilience in humanitarian operations, which offers insights for practitioners to improve operational performance in presence of unexpected disruptions. The proposed causal loop model provides a catalyst for further research and discussion focusing on resiliency in HSCs.

Research limitations/implications

The model focuses on systemic relationships between resilience factors in humanitarian operations and should serve researchers and practitioners with a preliminary reference model for further development of HSCs resilience evaluation systems. The model is bounded to the qualitative aspects of system dynamics in order to visualize the feedback loop structure related to resilient HSCs.

Practical implications

The causal loop model provides a visual medium by which decision-makers can gain an overall understanding of the links between HSC resilience factors. Therefore, our model facilitates practitioners learning about dynamic complexities and multidirectional relationships between relief chain resilience factors along the three phases of readiness, response and recovery.

Keywords: Resilience, Humanitarian Logistics, Supply Chains, System Dynamics, Causal Loops, Performance Measurement

ICT ENABLED APPROACH FOR HUMANITARIAN DISASTER MANAGEMENT: A SYSTEMS PERSPECTIVE

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ABSTRACT

Purpose of this paper:
Each stage in the disaster management faces different challenges concerning information gathering, interpretation and dissemination. However, a comprehensive understanding of different Information and Communication Technology (ICT) systems utilised for humanitarian disaster management is limited. The paper follows a systems thinking approach to examine major man-made and natural disasters to comprehend the influence of ICT systems on humanitarian relief operations.

Design/methodology/approach:
A longitudinal, multi-case study captures the application spectrum of ICT systems for relief operations over the past two decades. The paper follows a systems thinking approach to examine ten major man-made and natural disasters to comprehend the influence of ICT systems on humanitarian relief operations.

Findings:
Multiple ICT tools such as geographic information systems, online webpages/search engines, social media, robots, artificial intelligence are being used for rapid disaster response and mitigation. Speed and coordination of relief operations have significantly increased in recent years due to increased use of ICT systems.

Value:
Broadly classifying the ICT systems into surveillance, decision support and broadcasting systems, a novel ICT-enabled model for humanitarian relief operations is developed.

Research limitations/implications:
In this research, secondary data on multiple past disasters is used to derive inferences and propose ICT-enabled model for humanitarian relief operations.

Practical implications:
A holistic understanding of a complex inter-relationship between influential variables (stakeholders, disaster stages, zones of operation, ICT systems) is beneficial for the effective management of humanitarian disasters.

PART II
SECTION 1 – SMART LOGISTICS & SUPPLY CHAINS

THE IMPACT OF BLOCK CHAIN TECHNOLOGY ON THE FINANCIAL ECOSYSTEM: A PROPOSED RESEARCH AGENDA

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Purpose of this paper:
The financial industry is witnessing continuous evolving and adoption of new technologies such as Fintech that has been embedded in the financial system for years (Ozili, 2018). One of the currently most promising technologies that is beginning to get attention and be implemented in the financial industry and Supply Chain practices is the block chain technology (BC) (Harris and Wonglimpiyarat, 2019; Tran and Nguyen, 2021). This research aims at illustrating the relationship between BC technology utilization and the financial ecosystem and concluding with proposed research agenda in this area.

Design/methodology/approach:
A generic review is conducted to provide more insights on new trends in the financial ecosystem and application of BC technology in the financial ecosystem. The generic literature review is done by gathering studies from the year 2008 till 2021 and from reliable databases. Based on it research aims are fulfilled where the relationship between BC and financial ecosystem is illustrated and research gaps in this area are identified.

Findings:
By investigating the available literature and research in this topic, several research gaps were revealed. Some of which had been addressed such as the conceptual relationships between technology and financial ecosystems. Also, the relationship between BC and the financial ecosystem is illustrated and confirmed by analysing the results of some chosen studies according to the research methodology.

Value:
Most of the available studies on BC technology focuses more on the technical side of its application. However, this study contributes to knowledge by focusing on the non-technical implications of employing the technology in the financial industry. This study also provides practitioners with insights on how BC technology can be implemented in the financial ecosystem.

INTRODUCTION

After the 2008 global financial crisis, the interest in addressing the systematic risk on the whole financial system and improving its infrastructure has increased. Then in 2019, Covid-19 acted as an accelerator for the adoption of digital channels in the financial industry and improvements in its infrastructure to overcome collapsing again. This has drawn much attention to what is so-called the "Ecosystems" (May, Levin and Sugihara, 2008; Baret *et al.*, 2020). The massive technological advancements that the financial sector have gone through made the future of cash to be debatable that cash is becoming obsolete and economies are becoming cashless (Fabris, 2019).

The financial industry is witnessing continuous evolving and adoption of new technologies such as electronic payments Fintech that has been embedded in the financial ecosystem for years (Svensson, Udesen and Webb, 2019). One of the currently most promising technologies that is beginning to be implemented in the financial services industry is the block chain technology (BC) (Savelyev, 2018). Its implementation in the current financial ecosystem will yield some advantages but it will also be challenged by many obstacles (Yeoh, 2017). Hence, it is important to investigate how the current shape financial ecosystem can be changed due to the application of the new technology and build a successful framework for its application.

This research aims at illustrating the relationship between BC technology utilization and the financial ecosystem, proposing a framework linking the technology to the financial ecosystem and finally concluding with proposed research agenda in this area. Accordingly, the structure of this paper is organized as follows: first, a literature review on different related concepts (financial ecosystem and its dynamics, Fintech and its importance and BC technology) is presented. Next, a suggested definition of financial ecosystem and illustration of conceptual relationships between technology and financial ecosystem will be proposed. Hence, the relationship between BC and financial ecosystem will be illustrated. Finally, conclusions and future research agenda will be outlined.

LITERATURE REVIEW

This section includes a theoretical background on the main research concepts including financial ecosystem, Fintech, BC technology and industry 4.0.

Financial ecosystem

The concept of "Ecosystems" has recently gained much attention. An ecosystem in its broad sense is a biological term which means the system we live in that includes all the living organisms in an environment that interact with the environment and with each other (Tsujimoto *et al.*, 2018). While in business the term was initially defined by Moore in 1993 as a foundation of organizations and individuals that interact to create value. The term "Ecosystem" consists of two syllabi "Eco" & "system" where the community is named "economic" for the ability to produce products and services and fulfil the needs of the society while "system" refers to that the organisms of the ecosystem can coevolve their capabilities and roles and tend to align themselves with the direction set by one or more central companies (Palmié *et al.*, 2020).

Two major world incidents have triggered the attention to adopt more changes in the financial ecosystem, which are the 2008 global financial crisis and the world pandemic COVID-19 (Spatt, 2020). To avoid the collapse of the system once more, researchers have realized that it is important to model not only the current structure of the financial ecosystem but also the dynamics of the underlying networks (Somin *et al.*, 2020). In the past only corporate stability and safety of employment affected the financial services industry but after 2008 many other forces played an important role such as technological innovation, process disruption, and business transformation. This resulted in adopting new ways of producing, offering and executing the financial services (Gomber *et al.*, 2018). Covid-19 came to act as an accelerator for the adoption of automation technologies in the financial industry such as Fintech and AI. This will force banks and other financial institutions to revisit their current infrastructure to support the new platforms (Baret *et al.*, 2020).

Financial Technology

FinTech refers to innovations in technologies to facilitate processes for financial services (Thompson, 2017; Heather and Zachary, 2020). Some of Fintech advantages are cutting transaction costs, improving quality of services and improving stability of the financial industry. Aided by the rapid technological developments and ICTs, technology providers were able to provide the financial services industry with personalized technological services (Lee and Shin, 2018). Fintech has gone through several stages of development over the years. Those stages were identified by Palmie et. al, as fsollows: (1) The first stage "prominent industry maturity" represented by E-payment technologies, (2) The second stage "symbiosis" where more new technologies are introduced such as BC, (3) The third stage "resilience" represented by complete transformation due to AI (Palmié *et al.*, 2020).

E-payment system refers to using electronics networks such as the internet to make cash payments without having to do any physical transfer of cash (RACHNA and Singh, 2013). E-payment technology has numerous advantages such as: virtual money transfer which is faster than traditional ways of paying, this reduces the risk of losing the money by

physically transferring it (Cai and Zhu, 2016). Regardless, E-payments have some drawbacks such as lack of usability due to "complex website interfaces" and also lack of safety and security which can lead to theft of payments and personal data (RACHNA and Singh, 2013; Nikbakht, Shahrokhi and Corriette, 2019). Despite having lots of advantages as discussed before, traditional Fintech is threatened to be substituted by other new innovations such as such as BC (Bodkhe *et al.*, 2020).

Block Chain Technology and 4th industrial revolution

BC is basically the underlying technology of Bitcoin, it is a distributed ledger technology that can securely allow performing and recording transactions without the need for a central authority (Ammbika and Rao, 2019; Mendling *et al.*, 2018; Harris and Wonglimpiyarat, 2019). BC has five primary characteristics which are (1) decentralized nature (2) Immutability (3) transparency (4) persistency (5) trust (Ammbika and Rao, 2019). The technology helps in authentication of transactions to overcome the security issues of traditional E-payment methods without relying on a single institution such as a central bank (Nowiński and Kozma, 2017). BC is one of the technological innovations that has the potential to replace current E-payment methods where BC is said to be able to address all the safety and security issues in the era of industry 4.0 (Bodkhe *et al.*, 2020).

The term industry 4.0 was initially used by the German government it is described as the age of cyber physical systems and is used to describe the group of recent technological advancements in manufacturing such as cloud computing, BC and more. It got the attention of the whole business ecosystem since it came around. Industry 4.0 came with the technological advancements that has made it possible for every part of the company to become automated (Tay *et al.*, 2018; Xu, Xu and Li, 2018; Mekinjić, 2019).

With the increased dependence on technologies associated with industry 4.0 as well as great dependence on the internet. Applications in industry 4.0 share data that continuously flow between different locations using the open internet channel threatening data security and privacy, so it is necessary to consider issues such as data redundancy along and security and privacy concerns. Having centralized technology solutions have always been a fail to mitigate the risk of data theft and lack of security. The introduction of the BC technology can resolve this problem as it has a decentralized nature (Bodkhe *et al.*, 2020). However, there are numerous obstacles faced by its implementation (Chang *et al.*, 2020).

Literature review findings

By reviewing research in this area it is found that research in the field of BC and FinTech can be categorized into two main categories (1) technical research: that studies the technology itself as well as technical issues regarding how it works and how it can be improved and (2) non- technical research: that studies the history of the technology, current as well as future areas for application of the technology (financial and non-financial), as well as challenges and regulations facing the technology. This research will focus on the research that investigate the non-technical financial aspects of the implementation of the BC technology in the financial ecosystem.

In conclusion, the BC has a potential to improve and develop the financial services industry, however the technology is still infant which imposes some disadvantages that need further future investigations (Hawlitschek, Notheisen and Teubner, 2018). Several significant research gaps were revealed in the area of Block chain implementation in the financial services industry. First, the definition and framework of the financial ecosystem are not clear. Also, there is no clear confirmation on the direction of the relationship between the BC technology and the financial ecosystem. Thus, unfortunately the effect of the implementation of BC technology on the financial ecosystem is still vague and there is no specific framework in literature that can be used as a guideline in the implementation of the BC technology in the financial ecosystem. Accordingly, the aim of this research is to

fulfil some of these gaps by illustrating the relationship between BC and the financial ecosystem. Upon these findings, this research will focus on gathering and analysing the results of previous research in the same area and propose a definition and draw a conceptual illustration for the relationships between the financial ecosystem and technology. Then concluding by proposing a future research agenda. Hence, the following section includes choosing the appropriate research methodology that can help in achieving the research aim.

RESEARCH METHODOLOGY

A generic literature review is conducted to provide more insights on new trends in the financial ecosystem and application of BC technology in the financial ecosystem and identify research gaps. Then some studies are chosen according to the following criteria:

- Different keywords used are Block chain, financial ecosystem, financial services and financial industry to find as much literature as possible that are relating BC to the financial ecosystem and find the most relevant ones.
- Reliable databases are used such as Scopus and Emerald
- Technical research papers are eliminated. Also due to variations between search engines of databases different refining techniques are chosen but mostly included journal articles, years 2008 (the year Satoshi Nakomoto identified that BC can be used as a standalone technology in other fields rather than crypto currencies) till year 2021 and they are all sorted by relevance
- The average of results are around 45 articles and chosen articles from all databases were 7 articles.

Next, the results of the chosen articles are analysed and compared. After that, by building upon current knowledge a definition for the financial ecosystem is proposed as well as a conceptual illustration of the relationship between the technology and the financial ecosystem. Accordingly the relationship between BC and financial ecosystem is illustrated. Finally based on the results of the generic review a research agenda for future research is proposed.

The previous methodology is used to answer the research main question which is "What is the relationship between BC technology and financial ecosystem?" This is addressed by answering three important sub-questions which are:
(1) What is a financial ecosystem?
(2) What is the relation between technology and financial ecosystem?
(3) Is there a relationship between the financial ecosystem and the BC technology?

RESEARCH ANALYSIS AND DISCUSSION

The following table shows the most important studies chosen using previously discussed criteria that highlighted the relationship between BC technology and financial ecosystem upon which research proposition will be formulated.

Authors	Journal	Research aim	Findings
Yeoh, 2017	Journal of Financial Regulation and Compliance	Examining the key regulatory challenges impacting BCs in the EU and the US.	BC can transform financial services industry. Laws and regulations could impact the technology development.
Oh and Shong, 2017	Asia Pacific Journal of Innovation and Entrepreneurship	Studying cases of Block chain application in Korea in 2017 to draw a business model innovation for financial institutions.	BC can lead to disappearance of existing financial intermediaries and the financial services relying on them. The distributed characteristic of Block chain cannot be applied when actually developing

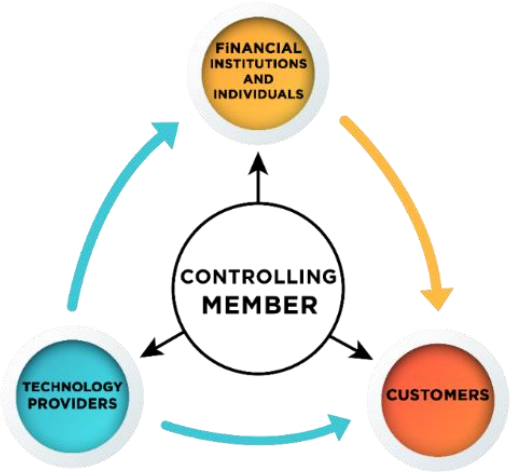
Cai, 2018	Journal of Accounting and Finance	Identifying gaps in Economics and Finance research regarding two applications of Fintech: crowdfunding and BC	Current research on Fintech is fragmented with limited theoretical grounding, BC can be regarded as two innovations that may disrupt traditional financial intermediation, BC also creates new intermediaries and the trust enables BC to eliminate intermediaries in some financial areas.
Harris and Wonglimpiyarat, 2019	The journal of future studies, strategic thinking and policy	Demonstrating how the BC banking relate to the pursuit of strategies and to what extent these strategies influence the direction and level of technology diffusion.	There would be increased competition from non-banks within the financial services industry. BC algorithms would replace the traditional role of banks
Nikbakht, Shahrokhi and Corriette, 2019	Journal of Managerial Finance	Investigating BC feasibility for electronic transfer payments and developing a conceptual framework for BC electronic payments.	BC technology has the potential to change firms' operations and implementation of e-payments. Application of the technology may be affected by the perception versus expectation of different types of organizations.
Dinesh Kumar, Komathy and Manoj Kumar, 2019	International Journal of Scientific and Technology Research	Identify the scope of BC in financial and industrial sector.	BC has enormous potential in the financial services industry through smart contracts allow executing contracts in a private environment without centralized control promises to change the way current business is done and IoT where it would help in speeding up financing the transactions of supply chain without the need of centralized management.
Chang *et al.*, 2020	Technological Forecasting & Social Change	Describing the impact and revolution of FinTech and BC in the financial industry and demonstrates the main characteristics of such technology.	BC can bring disruptive changes to financial services industry, with both positive and negative impacts. Three factors can impact the adaptation of BC technology, people and organization.

Table 1: Gathering of previous studies investigating the relationship between BC technology and financial ecosystem

In accordance to the previous study gathering the relationship between BC and financial ecosystem will be illustrated as follows:

By carefully analysing those studies, they can be categorized into two distinct groups: The first group includes Chang et. Al, 2020; Nikbakht et. Al, 2018; Oh& Shong 2018 and Yeoh, 2017. This group confirmed a two directional relationship between BC and financial ecosystem where the financial services industry can be affected by the application of BC technology and vice versa these. The second group includes Cai, 2018; Kumar K et. Al,

2019 and L.Harris& Wonglimpiyarat, 2019. This group confirmed one directional relationship between BC and financial ecosystem where financial services industry can be affected by the application of BC technology.
According to the conducted generic review and gathering of studies that show the effect of applying BC technology to the financial ecosystem, the following proposition can be formulated: *The utilization of technology could enhance the financial ecosystem and BC can be one of those technologies that can be employed in the financial ecosystem.*
To be able to address the research proposition the first research question which is "What are the components of a financial ecosystem?" should be answered. By reviewing the



available literature related to ecosystems and ecosystem thinking in business, it was found that there is no clear-cut definition for the term "financial ecosystem" or relation between the players of the financial ecosystem. It is obvious that the definition of an ecosystem is clear from the biological perspective. However, according to numerous researchers when adopting the ecosystem thinking on business or firm level the definition of the term depends on the context in which it is used (Tsujimoto *et al.*, 2018). By looking closely on research in business ecosystem which was firstly coined by Moore in 1993 (Palmié *et al.*, 2020). The definition of "financial ecosystem" can be formulated and proposed as follows:

"a type of business ecosystem which consist of a network of organizations (central banks, banks, insurance companies, hedge funds, pension funds, private equity…etc.) and individuals (brokers, investors, speculators, savers…etc.,) those organizations are most likely affected and controlled by a central force (the most powerful member of the ecosystem), they provide financial services of value to customers (who are also considered members of the financial ecosystems) through both cooperation and competition. All members of the financial ecosystem are affected by each other and by external factors which creates a dynamic environment that constantly evolves and adapt to new technologies in order to survive as a whole system".

Figure 1: Financial ecosystem framework

This figure shows that technology has a significant role in the financial ecosystem where it is provided by technology providers such as Block chain companies and Fintech companies to customers, financial institutions such as banks and individuals such as brokers and controlling members such as central banks to ease, monitor and regulate the process of providing financial services to customers which answers the second research question which is What is the relation between technology and financial ecosystem?

According to the previous results and by relying on previous research and despite the fact that there is no clear direction between the variables. It can be confirmed that there is a relationship between financial ecosystem and the BC technology where the financial ecosystem can be affected by the implementation of BC technology and the characteristics of the technology itself can be affected when implemented in the financial ecosystem due to the need for adaptation of the technology to the current shape of the financial

ecosystem. This answers the final research question which is "Is there a relationship between the main concepts related to the topic which are the financial ecosystem and the BC technology?"

CONCLUSION

BC technology is one of the most controversial technologies of the modern age. Some researchers are arguing that the technology may be disruptive while others are anticipating that the new technology is one of the most promising technologies of the age. However, BC technology has the potential to change the financial industry where it can be exploited in various FinTech applications such as stock market trading, smart contracts, record keeping, E-commerce, remittances, crowd funding, derivatives and much more. This will allow the world of financial services to overcome any risks that may lead to collapses such as 2008 global financial crisis and COVID-19. However, by investigating current research, there is still no developed framework that can be used and followed in order to implement the technology successfully in the financial ecosystem.

To conclude, there is still much to be investigated and added to knowledge in the area of BC technology. Hence, it is vital to give much attention to this area as BC advantages can help in drastically improving the way transactions and businesses can be managed. It is also important to investigate the effect of introduction of the new BC technology and how the implementation of the new technology will affect the current shape of the financial ecosystem, how it will respond and the role of regulatory bodies and government in the implementation of the technology. Also, developing a framework that helps in adaptation of the current financial ecosystem to aid in and allow the seamless implementation of BC technology. Finally, this research has contributed to theoretical knowledge by proposing a definition for the term "financial ecosystem" and drawing a framework for the financial ecosystem in order to be used in future research for the effect of BC implementation on the financial ecosystem. Also the research illustrated that there is a relationship between BC and the financial ecosystem but the direction of the relation is yet to be investigated.

Based on the conducted generic review and gathering of previous studies, A research agenda can be prepared in the light of the following revealed literature gaps:

1. There is a lack of research in the non-technical BC implications especially in the financial services industry.
2. There should be further investigations on the exact changes that should be done in the infrastructure of the financial ecosystem in order to allow for the application of the BC technology.
3. Due to lack of research that uses quantitative research approach, there is no clear research variables for the BC technology and financial ecosystem or clear directional relationship between them and accordingly no specific tools are present to measure the impact of implementing BC in the financial ecosystem.
4. All of the mentioned advantages are individualistic and does not represent the system as whole. Thus, it is important to conduct further research on the effect of applying BC technology in achieving a fully integrated financial system (ecosystem).

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An Assessment of Warehouse Management Practices: The case of Tuticorin, Tamil Nadu

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Purpose of this paper:
The main aim of this paper is to describe the current status of warehouse management practices in Tuticorin, Tamil Nadu (TN), India.

Design / Methodology / Approach:
A detailed descriptive analysis was made from the 55 registered companies of Direct General Foreign Trade (DGFT) that were taken for the study. In this context, the present study is experimental in nature and data were collected through structured formal interviews followed by filling the questionnaire by the respondents. The questionnaire was developed by taking into consideration factors like demographic variables like age, gender, designation. Parameters like categories of goods, equipment, infrastructure, security features, material tracking methods, importance of time indicators, and major challenges were explored while considering reviewing different categories.

Findings:
Our analysis was found that most of the warehouse companies in Tuticorin, TN, India are unorganized and fragmented due to a lack of skilled workforce, technology update, and inefficient multi and intermodal transportation. Automation implementation in entire warehouse operations must require to tackle certain obstacles such as mishandled raw materials and irregular inventory. Care should be taken from both the government and industry bodies to come up with a new idea to improve the infrastructure parameters to meet the global demand.

Value:
This paper provides a benchmark for organizations assessing the quality of their warehouse management practices and helps identify opportunities for significant improvement. Also, the study can be of use to warehouse operations to strengthen their existing warehouse management practices framework and need to compete with global standards.

Research limitation / Implications:
There are great opportunities for warehouse management practices and improvement within firms and across the supply chain management in Tuticorin, TN, India. Firms can and should collaborate with the Government of India and the State Government to implement appropriate measures of warehouse management practices in Tuticorin, TN, India.
The research study has limited only on warehouse companies in Tuticorin, TN, India and further research should extend to remaining major ports of India.

Keywords: Warehouse Management, Warehouse Management Practices, Tamil Nadu

INTRODUCTION:

Warehousing is often considered synonymous with pre-use storage of goods. An organization regards all physical distribution components as interdependent and equally important. Warehousing is a component of this kind of operations. The way to understand warehousing in modern times is to see it as one of several business functions, which are integrated together to provide a unique competitive advantage over others to enterprises. Earlier, this function was merely another tactical function related to inventory storage. But nowadays, warehousing and delivery represent core value-added services for many distributors; the need to reposition warehouse function has grown as fundamental strategic

sources of competitive differentiation and marketplace leadership. Computerization and other changes in technology have brought the warehousing function into the competitive strategy sphere. (Satish K. Kapoor, 2005) Usually, warehouse is defined as "a planned space to store and handle goods and materials effectively". Also warehouse is a vital hub at the center of the supply chain with goods and materials coming in and out in an organization. In order to meet customer requirements, Logistics play an important role and can be defined as the science of planning, implementing and controlling the efficient flow and storage of goods and services from the point of origin to the centers of consumption. Logistics comprises three main components at a broad level, namely transportation, storage and distribution. In addition, it is imperative for these three sub-components to work effectively. Transportation refers to port, road, rail and air infrastructure. In the logistics system, warehouses serve as processing or materials handling stations and in addition hold inventories that perform in buffering function. In modern days, warehouse performance functions will consider as two categories: Distribution and storage. Storage in logistics refers to warehouses and Distribution refers to freight forwarders, 3PL and some service providers.(Donald J. Bowersox, 2002) Warehouse mainly deals with storage of general commodities, refrigerated goods and other storage products. Warehousing sector is one of the fast-growing logistics industry's major segments in many developed and developing countries. The segment has evolved not only providing custody of goods but also offering value-added services including sorting, processing, mixing and packing. (Abhishek Roy, 2017) modern warehouses has been developed for the storage of perishable goods like vegetables, fruits, medicines, etc., have become essential in most developing and under developed countries. Warehousing sector in India is still in its primary stage and has a long way to go. Previously, managing the transport network and storage of finished goods, which was used to describe the supply chain strategy for most companies in India. Fortunately, the integration of the Indian economy with the global economy and various multinational companies locally established manufacturing facilities that have been helped bring global best practices to the domestic market. This has resulted in a gradual shift from simple transportation network management and godowns to a more integrated supply chain management system (Knight Frank, 2018).

This area of research is suggested significant on common findings of most of the Tuticorin Warehouses that do not study the current state of warehouse management. There are at least four major reasons why an industry would want to know the current performance of warehouse management in Tuticorin, TN. This study described has provided some insight but there is a need for a comprehensively research study thoroughly on warehouse performance measurement in entire TN. The aim of this study is to describe a research project that was undertaken to describe the current status of warehouse management practices in Tuticorin, TN.

REVIEW OF LITERATURE:

Earlier study revealed that, warehouse management system plays a key role in delivering customer satisfaction and efficiency. Further, warehouse design involves a wide range of decisions involving layout constraints and operational issues that have a serious impact on the performance and overall cost of logistics. This study presents decision support system for warehousing systems design, management and control (Accorsi et al., 2014). (Kłodawski et al., 2017) stated that the problems in warehouse facilities with the design and organization of logistics processes. In addition to that, the study emphasized the need to improve the actions of logistics facilities as a key aspect of increasing productivity, flexibility and reliability of the supply chain and the proposed methodology used as decision making tree with warehouse strategy selection probabilities to cater results in likelihood. Previous report revealed that in many production and goods-based methodology, warehouse inventory management system plays an important role. Also, they mentioned that RFID was best suited for the warehouse management system(Tejesh & Neeraja, 2018). Further, to verify the products attached to the tags with product information and their respective time stamps, the warehouse management system based on the architecture of the Internet of Things is developed. (Vishnu More, 2016) more stated in her article that, the companies are constantly forced to improve their warehousing

operations in today's competitive market environment and many companies have also tailored their value proposition to increase their level of customer service, resulting in changes in the role of warehouses. (Vlachopoulou et al., 2001), in addition to that, he tried to express the findings of the study to evaluate performance levels and enhance the productivity of warehouses by developing a different distribution of Warehouse Management Systems (WMS) and to analyze the impact of efficient and efficient warehousing on competitive strength, enhanced preservation and control and overall cost reduction. In another article, he insisted the importance of selecting warehouse site which involves comparing a market's spatial features with the company's overall corporate and marketing goals. Further, he stated that the decision to select the warehouse site is presented with a geographic information system-aided process and different factors that are likely to affect customer service and costs are defined and then integrated into an overall assessment (Ramaa et al., 2012) stated that warehousing function is very critical in a supply chain since it acts as a mediator in linking material flows between supplier and customer. For customer preference, many companies are constantly forced to improve their warehousing operations in today's competitive world. In their entire study showed that the performance levels and improve manual warehouse productivity through the development of a WMS framework and cost benefit analyses are studied. (de Koster et al., 2007), in every warehouse, order picking has long been identified as the most labour-intensive and expensive activity and the cost of picking orders is estimated to be as much as 55% of total warehouse operating expenses. Further, the order-picking process must be robustly designed and optimally controlled to operate efficiently. In real time, order-picking system development leads to promising new directions for research. (Hwang & Cho, 2006) showed the performance assessment model for the order picking facility for warehouse design in a supply chain management by reducing transporter travel distance. In addition to, they developed a systematic and practical computer program and it yields a potentially effective and useful for order picking warehouse issues in performance analysis with respect to warehouse design and operational parameters such as warehouse size, rack size, number of carriers and performance of the system. (Harb et al., 2016) Accumulation of studies explained the importance of engineering and IT systems can be used to improve business operation in United Company for Trading (UCT). The situation of UCT, a Lebanese company is reviewed before and after the implementation of the (WMS) and the result will explain how WMS improved operations and helped the company to reduce costs

The above review of literature highlights the multiple dimensions of factors related to warehouse management. The success of these depends on factors such as organizational support, suppliers' capacity and proper selection of suppliers, appropriate means of measurement of performance of warehouse management in different countries. The present study aims to deliver the current state of warehouse management practices in Tuticorin, TN, India.

RESEARCH METHODOLOGY:

The present aims to study on various parameters of warehouse operations and its challenges with reference to V.O.C. port trust, Tuticorin. This study is carried out in warehouse operation activities with regards to V.O.C. port trust, Tuticorin. In this context, the present study is experimental in nature and data were collected through structured formal interviews followed by filling the questionnaire by the respondents. The questionnaire was developed by taking into consideration factors like demographic variables like age, gender, designation. Parameters like categories of goods, equipment, infrastructure, security features, material tracking methods, importance of time indicators, and major challenges were explored while considering reviewing different categories. Primary data was collected through questionnaire and the secondary data were collected from related books, journals and websites. Registered companies from Direct General Foreign Trade (DGFT) were taken for the study. There are around 310 registered warehouse companies in DGFT whereas warehouse companies established within 5 to 10 years are found to be 63 in numbers which is taken as the population for the study. By using stratified sampling technique, sample size of 55 is chosen for the study. The

questionnaire consisted of 115 questions that were evaluated according to a 5- point Likert type scale which was tested for reliability. Table 1 shows reliability results in which Cronbach's alpha (0.872) indicates a healthy reliability. In the study, we have used the following tools for analysis: demographic profile of the respondents, descriptive analysis and correlation analysis with help of MS-Excel and SPSS at the required stage for analysis and interpretation. The result shows the current warehouse management practices in Tuticorin, TN. The result suggests to identify the scopes for the improvements in warehouse management in Tuticorin, TN. In general, the result will help the policy makers of warehouse management in Tuticorin to improve the existing performance of warehouse management.

FINDINGS:

Table 1. Reliability Statistics

Cronbach's Alpha	No. of Items
0.872	115

1. Analysis and Results:

1.1 Demographic Profile:

Out of 55 respondents, 50 (90.9%) are male and 5 (9.1%) are female. Majority of the respondents belong to the age group of 31-40 and 41-50 are 26 (47.3%) and 23 (41.8%) respectively. 24 (43.6%) of the respondents are executive employees.

1.2 Descriptive Analysis:

1.2.1 Categories of Goods stored:

Table 2. Categories of Goods Stored in Warehouse

Categories of Goods	Mean	St. Dev.
1. Agricultural Goods (AG)	4.87	0.635
2. Mineral Goods (MG)	4.77	0.732
3. Perishable Goods (PG)	4.03	0.993
4. Chemical Goods (CG)	3.83	1.243
5. Industrial Goods (IG)	3.77	1.220
6. Machinery Goods (MAG)	2.50	1.025

1.2.2 Equipment's inside the Warehouse:

Table 3. Equipment's inside the Warehouse

Equipment's	Mean	St. Dev.
7. Pallet Jacks (PJ)	3.90	0.928
8. Order Picker (OP)	4.50	0.523
9. AGV (AGV)	3.50	1.353
10. Side-Loaders (SL)	4.60	0.468
11. Drive Through or Drive-in Racks (DT or DiR)	4.65	0.462
12. Hand Truck (HT)	4.30	0.648

13. Push-back Racks (PR)	4.00	0.873
14. Conveyor Belt (CB)	4.50	0.525
15. Hydraulic Fork Lift (HFL)	3.80	1.246
16. Normal Fork Lift (NFL)	3.88	1.191

1.2.3 Usage of Infrastructure in Warehouse

Table 4. Usage of Infrastructure in Warehouse

Infrastructure	Mean	St. Dev.
17. ERP (ERP)	4.32	0.887
18. Stock Transfer, Stock Adjustment (ST, SA)	3.77	1.138
19. Personal Computer (PC)	4.56	0.542
20. Inventory Management (IM)	3.83	1.243
21. Smoking Detector (SD)	4.03	0.993
22. Inward Management (In)	4.11	0.960
23. Outward Management (Out)	4.15	0.997
24. Bar Code (BC)	4.42	0.666
25. Multiple Share Location (MSL)	3.78	1.356
26. Multiple Warehouse Management (MWM)	3.69	1.368
27. Internet Facility (IF)	4.48	0.644
28. Scanner and Printer (S&P)	4.52	0.554

1.2.4 Security Features in Warehouse

Table 5. Security Features in Warehouse

Security Features	Mean	St. Dev.
29. Alert System (AS)	4.06	0.838
30. Fire Alarm (FA)	4.18	0.822
31. Fire Extinguisher (FE)	4.52	0.532
32. Security Equipments (SE)	4.48	0.645
33. RFID (RFID)	3.86	1.067
34. GSM Based Temperature Alert Monitoring System (GSM)	3.42	1.320
35. SMS Alert Facility (SMS)	3.65	1.224
36. CCTV (CCTV)	4.56	0.520

37. Cage (Cage)	4.12	0.928
38. Motion Detector (MD)	3.22	1.404
39. Security Guard (SG)	4.64	0.456
40. Mobile Phone Locker (MPL)	4.22	0.807

1.2.5 Material Tracking Methods used in Warehouse

Table 6. Material Tracking Methods in Warehouse

Material Tracking Methods	Mean	St. Dev.
41. Bin Cards (BC)	4.52	0.538
42. Stores Ledger (SL)	4.54	0.502
43. Excel Spreadsheet (EXCEL)	4.48	0.589
44. ABC Analysis (ABC)	4.12	0.932
45. Just In Time (JIT)	4.06	0.965
46. FIFO and LIFO (FIFO & LIFO)	4.22	0.967
47. Safety Stock Inventory (SSI)	4.02	0.998
48. Economic Order Quantity (EOQ)	3.98	1.024
49. Minimum Order Quantity (MOQ)	3.86	1.136
50. Third-Party Logistics (3PL)	4.02	0.987

1.2.6 Importance of Time Indicators in Warehouse

Table 7. Importance of Time Indicators in Warehouse

Importance of Time Indicators	Mean	St. Dev.
51. Order Lead Time (OLT)	4.32	0.878
52. Receiving Time (RT)	4.45	0.647
53. Order Picking Time (OPT)	4.21	0.948
54. Delivery Lead Time (DLT)	4.25	0.930
55. Queuing Time (QT)	4.14	0.957
56. Put Away Time (PAT)	3.37	1.304
57. Shipping Time (ST)	4.08	0.918
58. Packing Time (PT)	4.40	0.652
59. Dock –to-Stock Time (D-ST)	3.45	1.323
60. Equipment Downtime (ED)	3.89	1.260

1.2.7 Challenges in Warehouse

Table 8 Challenges in Warehouse

Challenges	Mean	St. Dev.

61. Managing Warehouse Space / Layout (Layout)	4.12	0.878
62. Skilled Manpower (SM)	3.83	1.154
63. Accuracy of Inventory (AI)	4.08	0.692
64. Location (Loc)	3.79	0.187
65. Pressure of Seasonal Demand (PoSD)	4.04	0.409
66. Multiple Delivery Channel (MDC)	3.17	1.309
67. Eco-Friendly (ECO)	3.98	0.908
68. Picking Optimization (PO)	3.85	1.165
69. Redundant Process (RP)	3.46	1.275
70. Customer Demand (CD)	4.14	0.589
71. Time Management (TM)	3.85	1.171
72. Handling Product Damages (HPD)	3.76	1.063
73. Variation of Fuel Prices (VoFP)	3.04	1.574
74. Logistics Costs (LC)	4.19	0.547
75. Fleet Management (FM)	4.13	0.642

MANAGERIAL IMPLICATIONS:

The study can be of use to warehouse operations to strengthen their existing warehouse management practices framework and need to compete with global standards. Warehouse managers need to focus on technology dimensions is one of the major areas to improve as it is validated in the study. Our findings suggest that, both the government and industrial body should come up with a business models to improve the infrastructure parameters to meet the global demand. Compared to other developing countries, India's warehouse sector spends a 14% of GDP cost value in logistics. Since, most of the warehouse industries are unorganized and fragmented due to lack of skilled manpower, technology updated and inefficient multi-modal and inter-modal transportation. Equipping themselves with a latest technology like block chain technology, artificial intelligence, drones, Internet of Things (IoT), cloud computing, app development, etc., and further with the required knowledge and skills. The study also found, some of the major challenges faced by the warehouse industries like managing storage, irregular inventory and mishandled raw materials. To compete with global standards, warehouse manager must implement automation in order picking, material tracking, material handling, and proper training to the labour to overcome the existing challenges faced in warehouse management in Tuticorin, TN. Government of India has planned 35 Multi-Modal Logistics Park under the Logistics Efficiency Enhancement Program (LEEP) to help the logistics sector by cutting warehouse costs. In TN, Chennai has become one of the major logistics hubs in India due to the construction of clusters like Chennai-Bengaluru Industrial Corridor and the construction of highways, bridges in outside the city which fillip the development of more warehouse and logistics sector under the LEEP. Economy in TN is mainly driven by industrial components, automobile sector, food processing companies and port related activities are further driving up the stakes for Chennai's warehouse and logistics sector and also it has two major ports namely Chennai

port and Ennore port run by the Government of India and the new one Adani Kattupalli port constructed by Adani, private player. Under the Multi-Modal Logistics Park, Government of India should come with a strategic plan for Tuticorin like Chennai which will become major logistics hub in South India. Government of India has taken enough measure to boost logistics and warehouse sector by various measures such as the enactment of the 2007 Warehousing Act, the establishment of logistics parks and Free Trade Warehouse Zones (FTWZs) in conjunction with the introduction of the Goods and Service Tax regimes are promising growth for the industry. In addition, FTWZs need to be constructed in and around Tuticorin to boost the warehouse sector in South India. As like developed countries, private players in India will come up with an idea to develop these technologies and enhance the warehouse and logistics sector to compete in the global market. The study suggests that, under Make-in-India scheme, both central and state government should plan to develop a logistics technology hub like drone, IoT, artificial intelligence, etc. Further, under Skill-India and MSME, Government should impart knowledge from young students and intellectuals to nurture the business model of latest technology in warehouse and logistics sector.

LIMITATIONS OF THE STUDY AND SCOPE FOR FURTHER RESEARCH:

- The study has focused only on warehouse companies in Tuticorin, TN and further research should extend to remaining major ports of TN.
- Research can further have extended to different region in TN and a comparative study can also be carried out in different ports of TN.
- The study was focused on descriptive analysis of parameters in warehouse companies. Further research can concentrate on testing of hypotheses of various parameters.
- The present study raises important research questions such as:
    a. How warehouse companies will lead to cater more jobs in India?
    b. How multi-modal logistics park will boost the Indian economy?
    c. How digital India scheme will boost warehouse companies to all segments of the people?
    d. How Make in India will attract FDI in warehouse sector?
    e. How Skill India will nurture knowledge among young students and intellectuals on warehouse sectors?
    f.

CONCLUSION:

The present research aimed at exploring the level of different parameters among the warehouse companies in Tuticorin, Tamil Nadu. The rapid growth of e-commerce activity has created a rise in demand in warehouse companies in Tuticorin. To cater to this demand, share market investors and private equity funds are keep on investing more on developing warehouse companies in Tuticorin. The rollout of union budget on logistics and creation of new national logistics policy will further increase warehouse capacity across the region and thereby reduce the transportation cost.

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ENHANCING SUPPLY CHAIN INFORMATION SHARING WITH THIRD PARTY LOGISTICS SERVICE PROVIDERS

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Purpose of this paper:
This study evaluated the enhancement of information sharing practices with Third Party Logistics service providers (3PLs) in a supply chain solutions company that provides transport and warehousing software in Johannesburg, South Africa. The visibility of information has been a challenge for 3PLs who exist within South African supply chains (Bothma, Pillay, Rolle & Singh, 2014). Various studies have found that the complexity of dealing with too many networks (Cheng, Chen and Chen, 2014) ultimately leads organisations with limited levels of information to suffer inefficiencies related to growth in inventory levels, higher costs, ineffective communication and counter-productive relationships (Costantino, Gravo, Shaban & Tronci, 2013).

Design/methodology/approach:
A mixed methods case study was conducted to investigate the problem. Three rounds of primary data were sequentially collected, analysed and triangulated. An online questionnaire was distributed to a sampling frame of seventeen companies who were randomly selected from the population. A focus group interview was prepared for Dovetail executives who were purposively sampled to participate in the interview. The third round included the distribution of an open-ended questionnaire to explain and validate the findings from clients and executives who participated in the two rounds of data collection.

Findings:
Findings discovered that sharing information improves the collaboration of channel members, increases competitive advantage and ultimately leads to better customer service. They further revealed that lead times, unsynchronised technological infrastructure and a lack of commitment were a challenge at the solutions company. The improvement of relationships and continuous technological upgrades were recommended for improving visibility of information and effectiveness in the management of supply chains.

Value:
The value of the study contributes to the supply chain's dependence on 3PLs for value creation and the reliance on technology to share information amongst channel members. This study highlights that there is a need for organisations to build collaborative relationships with 3PLs and continuously update technological infrastructure in order to meet supply chain network goals.

Research Limitations/Implications:
The main limitation of the study was the low response rate because of the use of an online questionnaire and a small sample size. A small sample size implies that the findings of this study cannot be generalised.

Practical Implications:
The findings revealed that the availability of homogeneous technological infrastructure to allow processes to be synchronised was an issue. The study found that some problems existed with effectively managing relationships. These findings could be used to enhance information sharing practices thereby cultivate the management of supply chains, its operations and relationships amongst channel members.

INTRODUCTION

The use of information in supply chain management (SCM) for improved operations and better performance has been validated by various authors. According to Ding, Jie, Parton and Matanda (2014), the effectiveness of supply chain processes is reliant on the company's ability to access and share information. Marinagi, Trivellas and Reklitis (2015) maintained that sharing information facilitates the knowledge sharing and close relationships required for successful performance in supply chain operations. Chopra and Meindl (2016) asserted that information sharing provides the optimisation required by supply chain participants to make the best supply chain decisions. Mashiloane, Mafini and Pooe (2018) proposed that sharing information between supply chain partners can increase customer value, reduce manufacturing costs and significantly improve profitability.

Supply chains involve multiple channel members who perform different functions (Bailey, Farmer, Crocker, Jessop & Jones, 2015). The focus of this study is on Dovetail clients who have been provided with transport and warehousing software which enables them to offer Third Party Logistics (3PL) services to various supply chain networks. These clients have been provided with information sharing solutions by Dovetail in order to obtain and share information with channel members who they are servicing. The 3PLs are regarded as independent firms that provide integrated logistics services such as demand planning, order processing, transportation, warehousing, inventory control and customer service (Asthana & Bhat, 2015). The activities provided by 3PLs are considered as vital undertakings for achieving success in the supply chain and, as such, 3PLs have been regarded as an important success factor for supply chains globally and across sectors (Wang, Persson & Huemer, 2016). Some of the reasons that drive supply chains into outsourcing services to 3PLs have been cited as the acquisition of third party expertise, saving of costs and the reduction of time (Fawcett, Ellram & Ogden, 2014).

LITERATURE REVIEW

The dynamic nature of supply chains resulting from the constant flow of information and resources between various channel members, the involvement of multiple members in a network, and the volumes of products and services moved along the chain, cause complexity (Mbanje & Lunga, 2015). For this reason, information sharing with 3PLs in order to facilitate an efficient supply chain is important. Much research has stressed the role and influence of sharing information in SCM. Research conducted by Jermsittiparsert and Rungsrisawat (2019) found that supply chains are still essentially driven by the practice of information sharing. Dominguez, Cannella, Barbosa-Povoa and Framinana (2017) suggested that inefficiencies of the supply chain can be overcome by sharing information through collaborated supply chains. Huang, Hung and Ho (2017) proposed that, in addition to the coordination of activities and profits in SCM, information has to be shared in order to improve supply chain performance. According to Pooe, Mafini and Loury-Okoumba (2015), the practice of sharing information is regarded as the lifeline of the supply chain. The benefits of information sharing have been highlighted as enhanced collaboration (Qi, Huo, Wang and Yeung, 2017), better relationship management (Bailey *et al.*, 2015), accurate inventory management (Chopra & Meindl, 2016) and performance improvement (Modgil & Sharma, 2017). Findings by Sahin and Topal (2018) suggest that sharing information improves the performance of the supply chain and its competitive advantage. Anand and Grover (2015) suggested that the SCOR measurement framework can be used to evaluate supply chain performance. APICS (2018) indicated that this framework is considered to be the most appropriate model for performance measurement since it covers a wide coverage of measurement metrics. Evaluating the reliability, responsiveness, agility, costs and asset management of 3PLs has become a growing importance of 3PLs in the supply chain (Domingues & Macario, 2015) for adding value.

Much research has attempted to identify the factors that create a barrier for sharing information within the supply chain (KPMG, 2013; Bothma, Pillay, Rolle and Singh, 2014; Fawcett *et al.*, 2014; Marinagi *et al.*, 2015; Myrelid, 2015; Cox, 2015 and Huang *et al.*,

2017). A lack of communication, confidentiality, trust issues, incompatibility, power imbalances and time constraints were set out as some of the barriers that inhibit the practice of information sharing in the supply chain. KPMG (2013) found that 47 percent of supply chain companies cannot align real-time fluctuations in customer demand to their operations. PWC (2016) found that South African retail groups such as Mr Price and Pick n Pay reported efficiency issues where the demand for their products has exceeded supply or vice versa. These studies validated the findings of the Barloworld Supply Chain Foresight (2014), which suggests that South African supply chains need higher levels of information sharing.

Even though the benefits of sharing information have been understood to provide competitive advantage as a result of performance improvement and enhanced value (Anand and Grover, 2015; Domingues and Macario, 2015), South African companies are still reluctant to share information with their 3PLs due to barriers emanating from poor communication, trust and confidentiality issues. Although sharing information may make the organisation vulnerable to competitive practices within the supply chain, benefits of co-operation may be achieved if information sharing is carefully defined and managed. This study considers the performance of supply chains when many of the barriers to information sharing with 3PLs have been overcome and benefits of sharing information have been realised.

PROBLEM STATEMENT

South African supply chain members are still reluctant to share information with their supply chain partners due to unequal distribution of risks, costs, and benefits (Mathu, 2019). Bothma *et al.* (2014) indicated that South African 3PLs do not have complete visibility into the supply chain networks in which they are involved. A 2013 study revealed that nearly half of supply chain companies in the globe were only familiar with their immediate tier 1 partners and that they knew very little about their entire supply chain network (KPMG, 2013). Factors such as the quality, reliability and accuracy of information (Myrelid, 2015) have been said to impede the flow of information in supply chains. Relationship issues with channel members such as trust, a lack of collaboration and incompatibility limit the level with which information is shared amongst channel partners (Bailey *et al.*, 2015; Cox, 2015; Giri and Sarker, 2017). Supply chain complexities stemming from organisational, technological, financial and cultural issues (Giri & Sarker, 2017) have been reported as some of the barriers which prevent an efficient flow of information within supply chains**.** This implies that there is a gap in the sharing of information with 3PLs for achieving efficiency and performance improvement for the entire supply chain. Channel members who are reluctant to share information with 3PLs prevent the supply chain network from realising the benefits derived from sharing information. Given the value creation role of 3PLs in the supply chain, it is necessary to study the enhancement of information sharing with 3PLs.

METHODOLOGY

A mixed methodology was selected as the most appropriate design for this study. Reilly and Jones (2017:186) defined mixed methods research as a "type of research in which researchers combine both elements of qualitative and quantitative research approaches through the use of data collection, data analysis and inference techniques for the broad purpose of breadth and depth of understanding and corroboration". Mixed methods research permits a thorough investigation of information sharing at Dovetail. The quantitative strand was represented by data from Dovetail client's online questionnaire and the qualitative strand was represented by a focus group interview with executives at Dovetail as well as an open-ended questionnaire from both populations as a third data source. The three methods are required to strengthen the accuracy of the findings, enrich the analysis and the study findings, which will be required to answer the research questions and enhance the practice of information sharing in SCM.

The collection of data was executed in an explanatory sequential design which involves the collection of data in different phases (Rouzies, 2014). This comprises a multiphase research process in which quantitative data is collected initially, followed by an additional round of

qualitative data collection. The goal of implementing an explanatory sequence in this study was to discover findings from the qualitative study, which might have been omitted from the quantitative data collection phase, thus helping to explain the quantitative results. Equal priority was given to both qualitative and quantitative strands. The sequence and priority of the study is represented as: QUANT→ QUAL. The three stages involved in the collection and analysis of data are illustrated in figure 1.

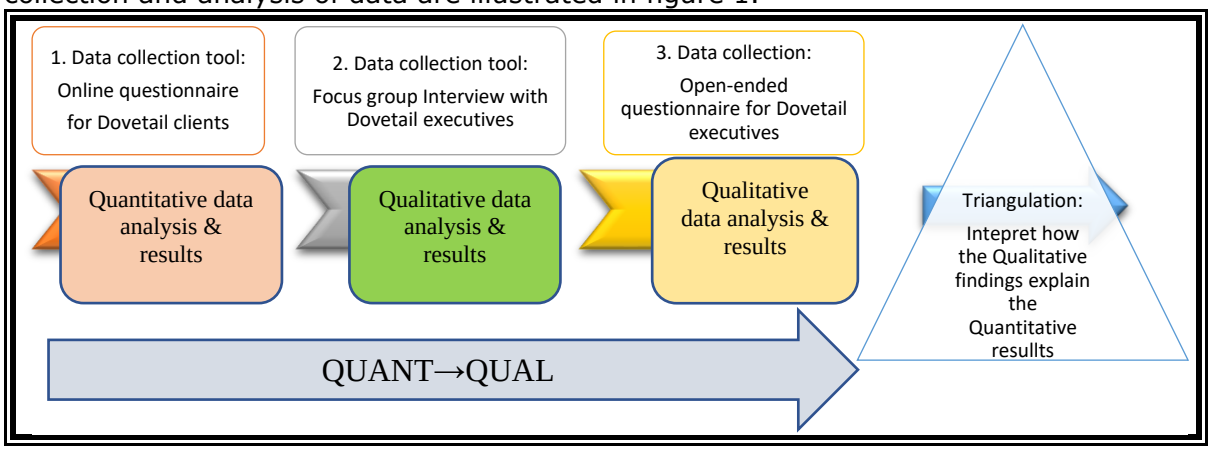

Figure 1: The sequence of data collection and analysis.

Stage 1: An online questionnaire was distributed to Dovetail clients in order to overcome time, money and geographical constraints. A sampling frame of seventeen companies was used to randomly sample employees from the population. The type of data collected by the questionnaire tool comprised of three sections. Section A related to the respondent's biographical information, section B related to the respondent's perception about information sharing and section C related to the respondent's perception about their company performance. This strand represented quantitate data and the IBM statistical package SPSS version 25 was used to analyse descriptive data. The statistical methods used to analyse and present the data included the univariate technique which was used to examine the distribution of demographic data; cross-tabulation which was used to compare variables between factors; the multiple response analysis which was used to assess marginal similarity between various factors and charts which were used to present the data in order to show and compare proportions between variables. Measures to ensure credibility and trustworthiness were addressed by triangulating the data from questionnaires, interview and the open-ended questionnaire. Ethical considerations were fulfilled by obtaining ethical clearance, informed consent, voluntary participation and ensuring anonymity.

Stage 2: After the collection and analysis of quantitative data from Dovetail clients, a focus group interview was prepared for Dovetail executives. The aim for collecting this strand of data was to gain a deeper understanding and explanation of quantitative findings. Three executives were purposively sampled to participate in the interview. The interview questions were designed from quantitative findings obtained from the questionnaire analysis. The themes planned for the discussion were linked to the five objectives of the study. They included information sharing, types of information, the role of information sharing, channels of sharing information and the performance measurement of 3PLs.

Stage 3: A third round of data collection subsequently followed. It included the distribution of an open-ended questionnaire to Dovetail executives in order to explain and validate the findings from clients and executives who participated in the two rounds of data collection. Qualitative data was prepared by coding the transcribed data that was collected during the focus group interview and the open-ended questionnaire. Atlas.ti was used to analyse qualitative data obtained from the focus group interview and the open-ended questionnaire. Content analysis was chosen as the technique that was suitable for analysing the transcription of the focus group interview and open-ended questionnaire data. Hsieh and Shannon (2005:1278) defined this technique as the preparation of text data by systematically identifying codes and themes in order to interpret the content of the text. The data from the focus group was analysed separately from the data collected

through an open-ended questionnaire since the format of the two data sources was different. The focus group involved face-to-face interaction, whereas feedback was obtained from individual participants through self-administered questionnaires.

FINDINGS

Quantitative findings

This section describes the practices of information sharing from Dovetail clients from a quantitative point of view. It was established that some levels of information sharing between the clients and their 3PLs had occurred. It was found that clients traditionally relied on emails to share information. The information most shared with 3PLs was found to be customer-related information, such as inventory, delivery and customer service which is required for the fulfilment of customer demand. Problems such as high inventory levels, distortion of information, poor visibility, long lead times and poor decision-making were commonly experienced while using traditional channels of information sharing. This compelled clients to adopt the WMS and TMS to share inventory and transport management information with 3PLs. The main barrier to sharing information was recorded as a lack of commitment within supply chain partners. As a result of the reluctance caused by these barriers, supply chains suffered the consequences of long lead times which equated to distortion of information, increased supply chain costs, poor efficiency in the supply chain and sub-standard supply chain performance.

The McNemar's test was used to measure the difference in the performance of the clients before and after the implementation of Dovetail services. Pallant (2010) suggested that the test could be used to identify differences between two related groups. The KPI's against which the plan, source, make and deliver processes are measured were adapted from the factor analysis results by Zhou, Shou, Zhai, Li, Wood, and Wu, (2014). All the measurement variables had a Coefficient alpha above 0.07 and were therefore deemed suitable for use in the study. Respondents were asked to indicate their company's performance in relation to planning, sourcing, making and delivering in the supply chain. They were asked to describe the performance of their supply chain before and after the implementation of Dovetail information sharing solutions.

The data showed statistical significance since all the variables of the planning, sourcing, making and delivering processes had a $p < 0.05$. This suggested that these elements had improved. All the Mc Nemar's tests conducted to assess the performance of plan, source, make and deliver processes showed an improvement after implementing the Dovetail solutions. Even though some processes showed relatively higher improvements than others, it can be concluded that the respondents indicated an overall improved performance in their supply chains after the implementation of Dovetail services. This indicates that sharing information improved the overall performance of the supply chain network as suggested by (Marinagi *et al.*, 2015 and Huang *et al.,* 2017).

Qualitative findings

Sequential data collection and analysis was implemented in order to explain and validate the findings from statistical analysis. The data from the focus group interview was used to interpret the quantitative findings. The data confirmed that all types of information were shared between Dovetail clients and their 3PLs even though other types were observed to be at higher levels while other types of information were shared at lower levels. The analysis of the executive's data endorsed that there was an essential role of sharing information at the solutions company, as reported from quantitative findings. Even though traditional methods of information were still relevant, automated technological systems were found to be the best channels for sharing information. Synchronisation and technological fit were emphasised as important factors to allow a seamless flow of information. The executive's perception on performance measurement validated the results from the Mc Nemar's test. The test suggested that information sharing had improved the overall performance of clients and their 3PLs at the solutions company.

In addition, the collection of a third data source provided an opportunity for the research questions to be answered with credibility by comparing the data from clients and executives who were asked to provide their opinion on the same set of questions. The data revealed

that there were a lot of similarities between the opinions of the clients and executives at the solutions company. Some differences between the two populations emerged including the executives, who advocated for more frequency in information sharing for some types of information, as compared to the clients who were reluctant to share more information because of a lack of collaboration and poor technological systems. Other differences emerged in the perception of the role of information sharing at the solutions company, where the client's perception was on the overall improvement of customer service and the executive's perception on the collaboration of channel members and the attainment of overall objectives of the supply chain network. The variance of opinion from the two populations was justified by their positions in the organisation. These similarities and differences support the assertion by Jogulu and Pansiri (2011), that the sole collection and analysis of a single source of data do not always provide a clear understanding of concepts. Therefore, additional evidence of qualitative data may provide a stronger interpretation.

DISCUSSION AND CONCLUSION

The findings of this study have confirmed that information sharing has a positive impact on the effective management of the supply chain. This section amalgamates the findings from the three data sources collected. The findings in this study have business implications for supply chain channel members for the enhancement of information sharing. The analysis of the findings can inform decision-makers and clients about effective measures to take in enhancing information sharing in their supply chains.

i. **The role of technology** was found to be crucial in managing the flow of information in the supply chain. The triangulation of the results showed that the practice of information sharing has the capability to improve the overall performance of the supply chain. These findings postulate that supply chains rely on IT solutions and businesses who provide them in order to effectively execute their organisations' operations and meet the strategic goals of their supply network. Supply chains are expected to invest in technological infrastructure that allows individual networks to execute their roles with complete visibility. These empirical results are compatible with other studies conducted on information sharing and technology in SCM. While the cost of obtaining supply chain solutions to facilitate information were found to be the smallest barrier to adopting this practice in this study, several studies have indicated that the cost of obtaining technology should be set off by the benefits derived.

ii. **Long lead times** were found to be recurring problems. The persistent threat by long lead times to supply chains implies that organisations should consider improving the real-time applications of technology for sharing information, in order to reduce lead times that are associated with plan, source, make and deliver processes. The lack of commitment was considered as the most prominent barrier by clients for information sharing.

iii. **Insufficient information visibility**, channel members who lack synchronised technological infrastructure to facilitate the flow of information, commitment issues, and a lack of awareness were some of the challenges that were found to affect the efficiency of supply chains. This data implies that some problems existed with effectively managing relationships with 3PLs in order to achieve the supply chain network goals. Companies should strengthen their relationships with 3PLs and other channel members in order to improve commitment towards the supply network.

iv. **Collaboration** with its suppliers was emphasised by clients and executives as the greatest benefit of information sharing. This suggests that the collaborative nature of sharing information was recognised and embraced by those who have adopted the practice of information sharing. Channel members should continue to collaborate with other members within and outside their supply networks in order to intensify the benefits of information sharing.

The value of the study contributes to an existing body of knowledge about the significance of 3PLs and information sharing in supply chains which could be subsequently used to develop publishable research articles. The study highlights the need for channel members to develop collaborative relationships with 3PLs who provide valuable services that are required for meeting the needs of the entire supply chain. The findings could be used to

cultivate the management of supply chains, its operations and relationships amongst channel members. The study furthermore stimulates a critical debate on how organisations rely on technology in supply chains and how there is a need for organisations to continuously update technological infrastructure in order to meet supply chain network goals.

The major limitation to this study was the restricted generalisability inherent to a case-study methodology, a small sample size and a slower response rate. Although the findings of his study are limited to a single solutions company, the insights suggest that the results can be universal to supply chains in South Africa. This is supported by findings from Mashiloane *et al.* (2018) which discovered a significant positive relationship between information sharing and supply chain performance. Future researchers can extend the study to a wider client base in other sectors of the supply chain for cross-checking. It would be beneficial to increase the sample size for improving statistical power and generalisability of the results. A longitudinal study could also be conducted to track the progress of information sharing, to establish the changes and improvements that might occur over time, and to identify other supply chain trends and best practices.

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The Role of Blockchain Technology on Shaping Digital Supply Chain Features Influencing Customers Relationship: A Systematic Review

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Purpose of this paper:
The integration of Digital Supply Chain (DSC) is becoming increasingly dynamic, impacting all nodes across the supply chain, especially the players/customers down the involved which occasionally find it problematic to easily adapt to the everchanging global business trends. In the continuous race for survival, DSCs are constantly embedding new technologies to enhance their performance, such as the Blockchain Technology (BCT) as it ultimately influences the supply chain partners/customers relationship. Thus, the purpose of this paper is to propose a framework of the variables identified to illustrate the role of BCT on shaping DSC features influencing customers relationship along the supply chain.

Design/methodology/approach:
This paper conducts a thorough systematic literature review that aims to identify the characteristics of BCT and DSC features which eventually influence SC customers relationship.

Findings:
This paper explores the main variables of BCT, DSC and the key influential drivers for the players/customers along the supply chain. Accordingly, the research introduces a conceptual framework which identifies the variables of BCT and DSC and elaborates the key indicators/drivers of the supply chain customers relationship, in attempt to investigate the correlation of the variables.

Value:
To the author's knowledge, no academic papers are published in leading academic journals that investigate the relationship between BCT, DSC and SC customers relationship from a theory-based perspective.

Research limitations/implications:
The proposed framework can bring valuable insights for future research development, although it has not been tested yet.

Practical implications:
BCT and DSC encompass the potential to significantly change customers relationship along the SC. Managers, practitioners and all involved in the digitalization phenomenon can utilize the framework as a starting point for other business digitalization projects.

INTRODUCTION

The way businesses are managed have dramatically changed over the last decades fueled by rapidly developing technologies and increasing globalization. Kemp (2019) mentioned in a World Economic Forum (WEF) article that it is vital for survival that businesses strive to cope with the ongoing advances in the current business in order to withstand the business cycle through adapting to the latest economy trends such as shared economy, cycle economy, fourth industrial revolution through the adoption of new technologies including; Internet of Things, artificial intelligence, robotics,3D printers, and Blockchain Technology (BCT). BCT is a highly pursed and trending technology identified by the WEF as one of the six megatrends in computing likely to shape the world in the next decade, due to its capability to create a trusted and transparent ledger of transaction information

which reduces the cost for businesses through optimizing their daily business transactions and efficiently improving their overall business operations (Franciso and Swason,2018).

BCT gradually entered many organizational aspects, such as Supply Chain Management (SCM), and through BCT traditional Supply Chain (SC) transmuted in to Digital Supply Chain (DSC). Digitalization is aimed at stipulating the necessary information on important elements and business processes, on bottlenecks and interruptions, as well as on options for optimizing key indicators for effective resource usage and cost reduction to achieve social, economic and environmental objectives. Digital technologies help create innovative SCs, taking into account the product life cycle, its impact on the environment, not only in the production process, but also in use, while optimizing costs and minimizing the negative effects of production and consumption (Igor et al., 2019).

Accordingly, as DSC features become an actual necessary part of the business world, finding technologies to support this phenomenon is essential. In order to realize the importance of this research, efforts have to be focused on the recent trends which triggered the need for advanced technology such as BCT, and its impact on DSC features which ultimately influence customer relationships down the SC. Therefore, this paper aims at proposing a framework to illustrate the role of BCT on shaping DSC features influencing customer relationships along the SC. The paper provides a theoretical framework derived from previous studies and review to consolidate the discussed discipline. Consequently, the structure of this paper is organized as follows: first a systematic literature review is presented on the integration between BCT,DSC and customers relationship down the SC. Then, an inductive methodological approach is followed to identify the main drivers of BCT in DSC and the main variables impacting the customer relationship patterns down the SC. Next, findings alongside the suggested conceptual framework are drawn. Finally, suggestions for future research and conclusions are defined.

LITERATURE REVIEW

This section illustrates the core concepts of the research variables; BCT, DSC and Customers relationships along the SC to conclude with the research gap which will lead to the research proposition.

Scope of BCT enabled DSCs

Many digital technologies have been adopted over the last few years and utilized in SCM to enhance its performance from a technological perspective such as; artificial intelligence, augmented reality, the Internet of things, 3D printing, virtual reality, robotics drones and blockchain technology (Veynberg,2020). Nakamoto (2018) identified BCT as one of the most promising technologies with great potential. As BCT was first introduced in the bitcoin context, it has since then flourished in many other areas with further capacities. SCM is one of the areas which have recognized the potential capabilities of enabling BCT in their operations. Thus, this realization drove the transition of traditional SC to DSC enabled by technologies such as the BC. One formal definition of BCT, provided by Risius and Spohrer (2017) is:

"BCT refers to a fully distributed system for cryptographically capturing and storing a consistent, immutable, linear event log of transactions between networked actors. This is functionally similar to a distributed ledger that is consensually kept, updated, and validated by the parties involved in all the transactions within a network. In such a network, blockchain technology enforces transparency and guarantees eventual, system-wide consensus on the validity of an entire history of transactions".

Despite the formal definition, it has been identified by previous researchers that due to the novelty of this subject it is difficult to generate a consensual definition. For instance, Min (2019) defined BCT as: "a decentralized mesh network of computers linked to each other rather than through a central server". Kamble et al (2018) defined BCT as " a peer to peer

transaction platform which does not need any third party intermediary". Another recent BC definition was conducted by Cole et al (2019) which defined BCT as a problem-solving technology that creates end to end transparency and a decentralized environment for transactions, where all entries are recoded on a public or private ledger that is visible to users.

In SC context it is clear that BCT works as a digital logbook of transactions, Field (2017) highlighted that BCT will lead to improvement of SC visibility and efficiency, as increased transparency will make it possible to react in real time to unforeseen events. Hence, with the COVID-19 outbreak, different industries all over the world witnessed the significance of digital technologies, which became a necessity for survival (Narayan and Tidstorm, 2020). As the pandemic revealed the deficiency of SC preparedness across industries, various researches indicated that adoption of BCT based SCs can enhance resiliency through the main features of BCT which provides (1) transparency (2) security (3) traceability (Nandi et al., 2021; Wyuts et al.,2020;Sarkis et al.,2020;Kouhizadeh et al.,2021;Treiblmaer 2019;Saberi et al., 2019).

Researchers discussed the relationship between BCT/DSC from perspectives such a profitability and efficiency, but absence of study has been found regarding the relationship between BCT enabled DSC from alternative objectives. Also, most of the research conducted discuss the topic from a conceptual behavior perspective but a shortage of focus on the influence of the impact of utilization of digital tools such as the BCT in DSCs on customer relationship down the SC exists. Therefore, the research proposition is that BCT enabled DSC will have impact on customer relationship altitudes.

DSC/customer relationship integration perspective

As various researchers have identified the end customer as the driving participant of SCs, the ability for a SC to be responsive in a customer-oriented manner towards the environmental changes becomes a priority to ensure the satisfaction of the ever-changing customer needs and wants (Yu et al,2013). As witnessed in the COVID 19 crises, organizations who lacked SC resiliency encountered major losses. Nandi et al (2021) elaborated in their research that during the COVID-19 crises, SC digitalization played a major role in maintaining sustainable SC operations. As the pandemic triggered both organizations and individuals to increase virtual collaboration as a substitute for physical actions. Thus, DSC is characterized by the strategic and operative exchange of information between SC partners to enhance communication between and across the chain (Chen and Paulraj, 2004). In the current era, the interorganizational coordination is achieved through virtual links between information systems enabling digital processes involving suppliers and customers in the SC (Korpela et al,2017). According to Santos and Eisenhardt (2005) properly automated SCs are found to be more efficient, while Mikkonen et al (2017) elaborated that DSCs provide systematic integration and bundling of information about products and services which create additional value for the end customer. As Reinartz et al (2019) proposed in their research that on a customer level, digital transformation of SCs can provide multiple benefits such as (1) Convenience (2) relevance (3) experience (4)empowerment (5) savings. Comprehending the value creation capabilities of digitalization is strategically vital for businesses. Ardito et al (2018) supported the idea of the potential benefits DSCs could provide to the customers and identified that through DSCs, organizations can better manage their relationships with their customers. As digital technologies provide SCs with better integration possibilities where data could be easily acquired and shared between SC participants.

Developing on the current body of knowledge, it is rational to conclude that the association between BCT and DSC has congruent potential for SCM (Treiblmaer and Beck 2019).
Unfortunately, while this concept is clearly sound on a conceptual level, the actual implementation is intrinsically difficult and hardly realized in practice (Büyüközkan and Göçer, 2018) as no specific/fixed measures have been assigned in the literature to assess the impact of the BCT/ DSC integration on customer relationships.These literature review

findings assisted the researcher in choosing an appropriate research approach to identify the main drivers that can accelerate the integration between BCT/DSC and customer relationship as well as the main influential variables that drive the customer relationship.

RESEARCH METHODOLOGY

In order to achieve the research, aim the following research questions were formulated:
RQ1: What is the BCT impact on DSC features influencing customer relationships down the SC?
RQ2: What are the main BC variables enabling DSC?

The first research question was answered through a narrative review in order to investigate the impact of BCT enabled DSC which influence customer relationships down the SC. The narrative review focused on analyzing the publications in the areas of BCT with special focus on its impact on SCs and the enhancement of the relationships of the different customers involved within the SC. Following the narrative review which resulted in the construction of a structured literature review, a systematic review was conducted following the three stages proposed by Webster and Watson (2002): (1) identification of the relevant literature (2) structuring the review (3) guidance of future research through the development of a research model.

Identifying the relevant literature

To identify the relevant literature, a systematic literature review approach was established, as it is a referential method to organize, synthesize and identify potential opportunities as well as evaluating obstacles and limitation based on previous studies (Queiroz et al, 2019). This was concluded through three main online databases (Emerald, ScienceDirect and Scopus). The research was only applied to publications that consider frameworks or models of BCT/DSC research published between 2008 to 2021 due to the recentness of the topic. The research mainly covers a B2B perspective as the authors intend to analyze the previous findings over the past decade from this perspective due to its strategic importance. As Nasiri et al (2020) identified that the majority of the companies concentrated on B2B transactions (84%), whereas 16% of firms earned their revenue from business to customer (B2C), which is why concentration on the B2B perspective is strategically vital. Different search term sequences and strategies were applied for each electronic database due to the absence of standardization between them. ch as possible relevant literature while excluding gray literature. Keywords which were used include, blockchain, BCT, SCM, DSC, digital technologies, customer satisfaction, customer relationship, customer relationship management. This selection is considered in the title, abstract and keywords of the article.

The first search yielded a total of 291 articles (108 in Emerald, 106 in Web of Science, 77 in Scopus,) that were saved in the reference management software "EndNote" in order to facilitate the screening process. After removing duplication in EndNote, the list resulted in 212 papers which were then scanned over two stages.

Stage 1: within the 212 identified articles we conducted a full search in the articles' title, abstract and the keywords to identify their suitability. The main elements considered at this stage, where the area of application is SC, the reference to a developed framework or a model of the variables. Articles referring to a correlation among the BCT and DSC that could potentially lead to an impact on customer relationship. Articles not directed to research on the influence on customer relationships have been disregarded at this stage. This stage concluded with a total of 106 articles.

Stage 2: at this stage of the selection process, all 106 articles were fully evaluated for their suitability to be considered based on their content (influencing variables of BCT enabled DSCs and the influential drivers on customer relationship), methodology used, model development and their practical implications. The second stage of the review concluded with a total of 33 articles to be included in the main analysis. The remaining articles from the second stage were used in the general discussion part of the paper.

Structuring the review
In order to structure the 33 selected articles for the main analysis, a synthesis matrix was developed. Prerequisite to identify the variables, the proceeding grouping was considered: research domain, framework/model, variables/drivers and related practical implications. Furthermore, the text was coded into manageable content categorize to reflect variables related to BCT, DSC and customer relationship. The structure of the final matrix considered: author, year; journal; research aim; tools used; area of study/theory; model/ framework identified; and variables identified.
Developing a conceptual model
The conceptual framework for the present study was developed by conducting an extensive literature review on BCT, DSC and customers relationships along the SC.

FINDINGS AND DISCUSSION
SCM has been striving for a long time to provide the missing links to the different level of customers down the SC in order to accelerate and improve their connection along the SC. Therefore, the narrative review declared that there is a distinct link between BCT and SCM as authors identified BCT as a technology that promotes productivity and efficiency for SCs (Blossey et al. 2019; Gurtu and Johny,2019; Cole et al.,2019). Moreover, the review confirmed that technology enabled SCs, now recognized as DSCs have an influence on the customers relationship within the SC. Therefore, based on the narrative review, the research proposition was confirmed, the link between BCT and DSCs and their influence on customers relationships along the SC was definite (Li et al., 2017; Y. Wang et al., 2019; George et al. 2019).

Accordingly, based on the findings of the first research question. The researcher conducted a systematic review to answer the second research question by identifying the BC variables enabling DSC. As BCT provide transparency and security this enables the customers to trust the process and reduces their opposition to the change (George et al. 2019). From a customer perspective as BCT stimulates digitalization along the SC, this guarantees that the players/customers within the SC gain the benefits of BC such as: product information, including origin, production, modifications and custody, which provides highly needed assurance to all customer levels within the SC (Montecchi et al. 2019).This could be done through the inclusion of BCT in the SC which is now recognized as the transition from traditional SC to DSC. This transition had a remarkable impact on the customers, even though their adaptability to such changes and trends is not always easily tranquil.

The systematic review focused on the selected 33 articles according to the criteria mentioned previously using a data extraction table, upon which the initial synthesis matrix was conducted through selecting relevant studies related to research questions, approach and core contribution. While the rest of the articles were used to capture observations that assisted in drawing the review conclusion. Following the reviewed, four main functions were identified in the review models: variables focus, prioritization, integration and causality. These functions helped with development of the conceptual framework for linking BCT/DSC and players/customers relationship down the SC. The developed framework guides future research and places importance to practical implications.

BCT enabled DSC variables were identified from different perspectives such as operational, tactical and strategic (e.g., Cole et al.,2019, Gimenez and Lourenco,2008). A wide range focused on the context of sustainability. While others used the functionality of the technology such a problem solver, relationship manager and authenticator (George et al., 2019). It is worth mentioning that when searching for the variables there was scarcity in research focusing on BCT as a form of digitalization in SCs, researches focused more on other digital technologies such as 3D printing, IoT, Cloud Computing and big data analytics. (Hoberg *et al*.,2015; Buyukozkan and Gocer, 2018 and Igor *et al.,*2019). Moreover, Table 1 illustrates the key drivers of BCT adoption in DSC. It was highly elaborated by previous researchers, that one key characteristic of BCT is its ability to increase trust among

stakeholders within the SC process. As the deployment of the technology acquires more trust and streamlines the related business process, it also decreases cost while increasing efficiency as it improves relationships along the SC players. According to the mentioned papers in Table 1, enabling visibility/traceability of transaction, the flow of information across the SC is also constituted through BCT, which eliminates the need of intermediary and enables real time tracking through traceability. On a technical level, another key characteristic of BCT is its ability to ensure network security. As each block contains its own unique ID and has the hash of the previous block this ensures transaction security as all transactions are recorded and validated by the users in the network. They are also stamped, arranged in chronological order and connected to the previous block which enables irreversibility once added to the network. Withholding such vital characteristics, this drives SCs to integrate such a multi-purpose technology within their process.

Drivers	Reference
Trust	Koetsier (2017) Gurtu and Johny (2019) Collomb and Sok (2016) Hull et al. (2017) Michelman (2017) Nakasumi (2017) Patel et al. (2017) Li et al. (2017) Bonino and Vergori (2017) Wang et al. (2019) Tian (2016, 2017) Toyoda et al. (2017) Mackey and Nayyar (2017) Engelenburg et al. (2017) Kshetri (2017) Guo and Liang (2016)
Visibility/traceability	Mishra et al (2018) Pauka 2019) Mackey and Nayyar (2017) LU and Xu(2017) Bocek et al (2017) lee and Pilkington (2017) Tian (2017)
Security	Min (2019) Philip et al (2019) Gurtu and Johny (2019) Ksherti (2017) Fu and Zhu (2019)
Efficiency	Queiroz et al (2019) Koetsier (2017) Srivastava (2019) Allen et al (2019) Kim and Shin (2019)

Table 1: Drivers of BCT Adoption in DSC

Drivers	Reference
Trust	Paliwal et al. (2020) Rejeb et al. (2020) Kumar, A. et al (2018) Treiblmaier (2018) Dutta et al (2020)
Communication	Haddud, A. and Khare, A. (2020) Shaker et al (2020) Queiroz et al. (2019) Reniartz et al. (2019) Kim and Shin (2019)
Adaptability	Sheth (2020) Karmaker et al (2020) Ivanov et el (2020) Mollenkopf et al (2020) Dubey et al. (2018) Büyüközkan and Göçer (2018) Kamble et al. (2018)

Table 2: BCT enabled DSC/customer relationship

As previously mentioned, BCT is one of the trending technologies now being used to enhance different organizational areas. Figure 1 illustrates the capabilities of the BCT from a SCM context. BCT enables the enhancement of DSC and influences the SC flows through providing the following characteristics:

Trust: studies have shown there is a strong relationship between trust and BCT (Saberi et al., 2019; Y. Wang *et al*., 2019; Batwa and Norrman, 2020). Some researchers argued that trust is the main driver for applying BCT (Peck, 2017; Y. Wang *et al*., 2019; Batwa and Norrman, 2020). Others have introduced the concept of "digital trust", which claims to change the traditional methods of dealing with trust in business. For example, in

Gaehtgens and Allan (2017), Gartner stated that "It is often said that trust takes years to build, seconds to break and forever to repair. Digital trust, on the other hand, takes instants to build, an instant to break and is continuously adaptive". According to a recent literature review of 29 papers by Y. Wang *et al*. (2019), applying BCT in SCM has multiple benefits, most importantly is the technology's ability to create a trust-free environment based on the reliability and security of the information stored on the blockchain.

Visibility/traceability*:* According to the same study by Y. Wang *et al*. (2019), extended visibility and product traceability are the main and most deployed BC applications in the SC context. BCT provides a temporal record of all transactions, along with other related product specifications, such as sender, receiver, temperature, footprint and so on. Additionally, with installed sensors and Internet of Things (IoT) devices, real- time visibility can be achieved which will drive tracking and tracing applications to the next level (Li *et al*., 2017; Y. Wang *et al*., 2019).

Security: BCT enables improved data security and information sharing overcome issues such as corrupted information or information asymmetry due to the consensus mechanism.

Efficiency*:* as BCT facilitates digitalization of transactions, this results in less manual work and paperwork, less time validating processes and peer-to-peer transactions with no need for a central party, thus improving the efficiency of the SC activities.

Table 2, clarifies how previous literature have identified the main variables impacting the different customers relationship down the BCT enabled SC. It was derived that the customers relationship is mainly influenced by different sources, including trust, communication and adaptability. As previous research emphasized customers relationships are highly driven by the concept of "trust", it was considered as one of the main factors influencing customers relationships along the SC. As constant environmental changes take place, customers within the SC process are correspondingly vulnerable to constant trust issues, placing the concept of "trust" as the driving variable to impact the SC customers relationship statues. Another vital variable is the communication flow along the SC which enables integration and efficient collaboration among the SC members. Hence, as communication along the SC is improved, customer relationships are enhanced. Lastly, adaptability, which with the current environmental situation of the COVID 19 pandemic proved to be a dynamic variable with high impact on the customers relationships in SC. As Dubey et al (2018) incorporated, customers's ability to adapt to the continuous changes in the market is a tough process that withholds great capabilities that could impact SC customers relationships and provide SCs a competitive advantage.

A systematic review was then used to synthesize the literature findings and accordingly a theoretical framework was derived based on the existing literature which highlights the B2B influence of BCT based DSCs and the literature impacting the co-relation between DSC and customer relationship alongside the SC. As the selected articles for the research focused on the B2B relationship of the customers inside the SC. Such collaboration feature critical strategic qualities such as collaboration along the SC partners including the end customer which currently, in a customer driven market represent a vital nod in the SC. This framework fills existing research gaps and advances the understanding of BCT enabled SCs and their potential influence on customer relationships.

Theoretical framework:
In order to conceptualize the different aspect of this study, based on the reviewed literature, the following preliminary theoretical framework was developed. The research incorporates one independent variable which is BCT with its different influential variables (trust, visibility/traceability, security, and efficiency), one moderating variable which is DSC features within the SC flows (information flow, product flow and financial flow) and

one dependent variable which is customer relationship (trust, communication and adaptability).The following figure illustrates the theoretical framework of the study.

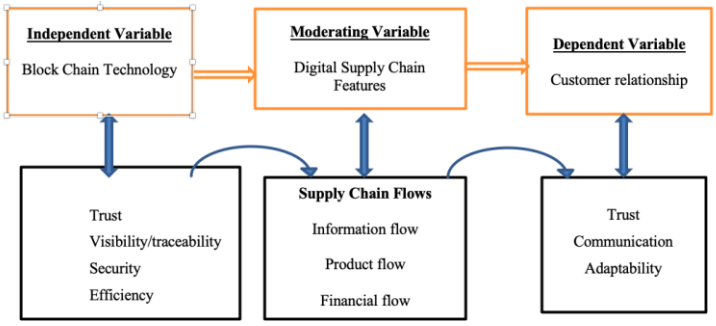

Figure 1: Theoretical Framework of the Study

In accordance to previous literature, the framework demonstrates that there is a relationship between BCT and DSC. As BCT aids in enhancing the relations of all customer levels along the SC, through enabling trust and improving communication to enhance adaptability of the given DSC features/ flow as they transform according to the outer dynamic environmental changes. As witnessed throughout the COVID 19 pandemic, which enforced companies to adapt to the concept of digitalization within their SC flows, through technologies such as BC to enable them to cope with the current environmental changes. Thus, influencing the relationship among all levels of customers along the SC by enabling trust and promoting enhanced communication along the SC to affluence the customers' adaptability.

CONCLUSION AND FURTHER RESEARCH

The systematic literature review, related to the BCT/DSC integration aiming to define the influencing variables of the BCT on the digitalization of SCs which could ultimately impact the relationship of the main SC nod, which is the customer. The literature revealed the following gaps:

1. Lack of study correlating the three main variables (BCT, DSC, and customer relationship).
2. The BCT variables are not unified, differ, and overlap in literature.
3. No specific measures assessing the impact of BCT enabled DSC on customer relationship.
4. No evidence that companies' implementation of theoretical approaches introduced in the literature, and if so, the level of impact on customer relationship is unclear.

To conclude, the blockchain and SCM management scholars have to unify their efforts to generate a clear understanding of the interrelation between BCT and digitalization of SCs, as both disciplines are unified by having an information systems' angle. Furthermore, there is an urgent need to derive the main influential variables induced by DSC on the customer relationship, which could impact the level of communication and collaboration along the SC. Otherwise, the positive integration will continue to remain an objective of the theoretical framework and overlooked in practice. As the extraction of these variables are believed to close the present gap in the literature.

To further develop and refine the proposed framework through applied based research. The current research is going to be supported by a quantitative empirical study on two levels in order. The first part is to conduct a survey with a number of local companies who have a BCT enables DSC to validate the variables derived from the literature and to further explore new BCT/DSC and customers relationship variables. The second part is to confirm the relationship of the variables through conducting structured interviews and focus groups

with selected experts to validate the variables and provide a roadmap for implantation. Finally, a proper conceptual framework with the confirmed variables will be developed.

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PITFALLS, STICKS AND STONES: UNDERSTANDING CHALLENGES INDUSTRY 4.0 POSES FOR INTER-COMPANY LOGISTICS

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Purpose of this paper:
Industry 4.0 implies a further digitization and interconnection of industrial value creation. Given its interconnecting character, Industry 4.0 has the potential to transform logistics and entire supply chains. When it comes to inter-company exchange, Industry 4.0 brings numerous challenges but in spite of its relevance, research lacks a comprehensive understanding. Our study contributes to this gap addressing the question "What challenges and risks does Industry 4.0 bring for inter-company logistics?"

Design/methodology/approach:
Conducting a mixed method approach, the paper combines a systematic literature review with a qualitative empirical study to develop a deeper understanding of challenges and risks Industry 4.0 implies for logistics. Firstly, conducting a systematic search, we identify 69 relevant publications and analyze them according to challenges and risks. Secondly, a qualitative-empirical multiple case study, based on 17 semi-structured, inductively analyzed interviews with experts from German industrial companies, complements the elaborated categorization.

Findings:
The paper provides insights into literature and combines the findings with qualitative empirical data. The results indicate, among others, challenges and risks in the logistics sector caused by Industry 4.0 when it comes to cooperation with suppliers and partners, in the organization and implementation, regarding data management, as for human and technological aspects, and regarding legal issues and standards. Hereafter, the results are discussed against the background of scientific publications in the field of logistics and Supply Chain Management.

Value:
The study aims at developing a comprehensive understanding of challenges and risks that Industry 4.0 poses for logistics. To the best of our knowledge, this study is among the first to shed light upon Industry 4.0 challenges and risks from a logistic and supply chain lens. In so doing, we add novel insights to the current state of research and discuss aspects contributing to the scientific and practical discourse.

Research limitations/implications:
Our paper's methodology entails some limitations, for example, restrictions in the literature analysis and biases during the interviews, coding procedure, and inductive analysis. In the course of the analysis, the study reveals several implications for future research. For example, insights from quantitative analysis and best practices cases of successful implementations would complement the findings.

Practical implications:
The study provides managers with implications on how to manage Industry 4.0 challenges. Deepening the understanding may help corporate practice to anticipate challenges in advance, to analyze, and address them proactively in order to adequately implement Industry 4.0 across corporate borders.

INTRODUCTION AND PURPOSE

Based on digitization and interconnection, Industry 4.0 is finding its way into all types of industrial companies including small and medium-sized enterprises (SMEs). Companies expect Industry 4.0 to bring far-reaching opportunities and potentials for value creation (Kagermann et al., 2013). Industry 4.0 key technologies, such as cyber-physical systems, Big Data analytics and Cloud Computing, are not only implemented within individual companies, but across horizontally connected value creation stages (Schneider, 2018; Müller et al., 2020). Thus, logistics is affected by Industry 4.0 managing the exchange between customers and suppliers. In spite of the opportunities, Industry 4.0 also entails a wide portfolio of challenges and risks especially when it comes to inter-firm exchange. Analyzing them is of utmost importance from a risk management's perspective for both researchers and practitioners, paving the way for a successful Industry 4.0 implementation across corporate boundaries. The difficulties for logistics outlined so far are mostly of technological and individual company-related nature. However, the discussion requires further consideration, especially from an inter-firm lens, relating to prevent recently encountered supply chain disruptions. Thus, the study addresses the research question:
What challenges and risks does Industry 4.0 bring for inter-firm logistics?
Based on a systematic literature review and a qualitative empirical study, the objective of this study is to develop a comprehensive understanding about this topic.

THEORETICAL BACKGROUND

Industry 4.0

Proclaimed in 2011 by the German government, Industry 4.0 implies a novel (i.e., fourth) industrial revolution. It bases on current trends in information and communication technology (ICT) applied in industrial production systems and industrial vale creation (Kagermann et al., 2013).
With developments in ICT, comprehensive measures for improvements are available in production-related applications leading to wide-ranging transformation processes. Among others, human-machine interactions change labor and create a cooperative environment characterized by virtual collaboration (Kagermann et al., 2013). Production and logistic processes become more flexible following vertical integration. Further, Industry 4.0 allows creating new data-driven and platform-based business models (Müller et al., 2020).
This study's understanding of Industry 4.0 bases on the definition of Kagermann et al. (2013), stating that Industry 4.0 is the real-time, intelligent, horizontal and vertical interconnection of people, machines, objects and ICT systems for the dynamic management of complex systems. This implies that Industry 4.0 does not end at corporate boundaries but has a great impact on value creation chain and on logistics.

Industry 4.0 challenges

In spite of the promised opportunities, a more nuanced view reveals several challenges, which only scarcely have been analyzed in research. Inter alia, investigation from a sustainability point of view, Birkel et al. (2019) find economic risks of Industry 4.0 such as misleading investments, threatened business models, and new market entrants. As far as ecological aspects are concerned, they describe an increase of waste following the individualization of value offerings ("lot size one") and a growing energy consumption of digital solutions. Job losses, organizational transformations, requalification, and company-internal resistance are social challenges. Further risks include technical risks, e.g., technical integration and data security, as well as legal and political risks, e.g., missing juridical clarity for human-machine interaction (Birkel et al., 2019).
Thoben et al. (2017) analyze three main categories of Industry 4.0 challenges. The authors subdivide challenges into technical, methodological, and business challenges. The technical problems include differing norms and standards given the heterogeneity of systems. Standards ensure interoperability between companies interconnected in a value chain. In addition, the quality of data collected by sensors and its comparability are crucial. Furthermore, challenges arise regarding information security and technical possibilities of protecting sensitive data. Further, companies need common definitions to successfully implement digitization projects. Business challenges of Industry 4.0 include investment risks and challenges regarding business models (Thoben et al., 2017).

The challenges Industry 4.0 implies for logistics in particular has not been analyzed in a sufficient manner calling for further attention which is the motivation for this study.

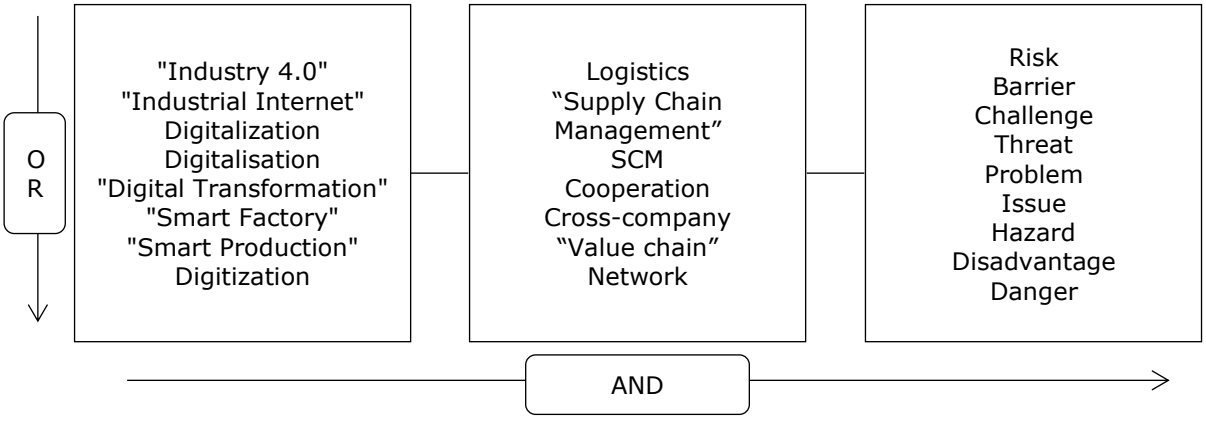
METHODOLOGY

In order to answer the research question, this paper applies a mixed method approach and combines a systematic literature review with a qualitative empirical study:

Systematic literature review

A literature review is conducted to develop a deeper understanding of challenges and risks Industry 4.0 implies for logistics. The analysis bases on five pre-defined steps: 1) selecting a time period, 2) selecting scientific data bases, 3) selecting relevant publication types, 4) defining key words, 5) selecting articles, and 6) categorizing and analyzing the articles (Tranfield et al., 2003). Firstly, a time period from January 2010 till August 2020 was regarded, as doing so includes publications from the upcoming of Industry 4.0 and includes the most recent state of research. Secondly, selected databases to search for literature include Scopus, Web of Science Core Collection, EBSCO Business Source Complete and ABI/Inform. Thirdly, peer reviewed scientific journals and specialist journals, book chapters, and conference contributions were considered as relevant publication types. Fourthly, key words are determined from the topics "Industry 4.0", "Logistics", and "Risks/Challenges", and hereafter consolidated into a search string (see Figure 1). The OR and AND search operators interlink the key word topics with a Boolean logic ensuring the sample comprises relevant publications.

Figure 1: Keywords and search string



Fifthly, applying the criteria and the search string to the data bases reveals several hundreds of publications. In the selection process, publications are excluded, for instance, if they are not relevant, if they do not meet quality expectation, and if they comprise less than five pages. In the end, a total of 69 relevant publications are identified. Sixthly, individual publications were classified into categories for further analysis and discussion.

Qualitative empirical approach

A qualitative, empirical research study complements the literature review providing additional in-depth insights. Qualitative-empirical multiple case studies have proven to be useful when identifying and examining a complex, encompassing, and evolving phenomenon like Industry 4.0, with multiple case studies increasing reliability, robustness, comparability, and replicability of results when compared to single case studies (Yin, 2018). 17 semi-structured interviews with experts from various German industrial companies conducted between July 2018 and February 2019 form this paper's empirical basis. The sample companies stem from the sectors electrical and electronics engineering (n=6), mechanical and plant engineering (n=6), automotive (n=3), consumer goods (n=1), and information and communication technologies (n=1). The information about the companies and interviewees were anonymized, all representatives stem from supply chain management positions from renown German industrial companies with long experience.
All interviews were recorded, transcribed, and hereafter categorized in a qualitative content analysis. In order to summarize the data without distorting the interviewees' statements,

we applied an inductive approach (Miles & Huberman, 1994). We followed the analysis procedure of Gioia et al. (2013) that comprises two steps: Firstly, the word-by-word interviewee statements are paraphrased. Secondly, the paraphrases are synthesized into superordinate categories. Thirdly, homogeneous categories are consolidated into subcodes, representing the highest aggregation of information generated from the empirical data and literature. Subcodes are then summarized into topcodes by the researchers, representing overarching topics derived from literature.
The findings from the literature review and the qualitative empirical study are then consolidated in order to develop a comprehensive understanding.

FINDINGS AND DISCUSSION

The paper's results retrieved from the literature analysis and the qualitative empirical approach are depicted in Table 1. The table presents the topcodes and subcodes developed from the empirical data consolidated with literature's insights, and it includes corresponding (exemplary) references from the literature analysis. Among others, challenges and risks in the logistics sector can be found when it comes to cooperation with suppliers and partners, in the organization and implementation, regarding data management, as for human and technological aspects, and regarding legal issues and standards. Given a limited space, only the most relevant aspects are discussed.

Suppliers and partners

Interconnecting several companies of different value chain stages to form a value creation network brings numerous challenges. Some companies and partners have a critical attitude towards changes, for example when implementing new processes and increasing transparency, which is especially true for SMEs. Therefore, incentives and stimuli are to be prepared and strategies to convince the respective partners. However, companies become dependent on this interconnected network (Fernandez-Carames & Fraga-Lamas, 2018; Müller et al., 2020).

Organization and implementation

Further challenges ascend concerning the organization and implementation of Industry 4.0 in logistics contexts. The implementation of digital technologies, the transformation towards smart value creation and the interconnection across corporate borders result in high (initial) investments and transaction costs. In addition, there are further follow-up costs, such as the qualification of employees and ensuring IT security (Birkel et al., 2019). However, the financial return of Industry 4.0 implementation in logistics is associated with high uncertainty and with unclear amortization duration. This is especially true, as not only the overall complexity of technologies and value creation increases but also the economic complexity (Birkel & Müller, 2020; Hofmann & Rüsch, 2017; Müller et al., 2020; Witkowski, 2017). Therefore, a calculation of the return on investment that takes into account several analytical and risk management considerations should recommend introducing new technologies (Illa & Padhi, 2018).

Data management

The results uncover new requirements regarding the security of data and systems and regarding the confidentiality, integrity and availability of high-quality data (Birkel et al., 2019). An increasing complexity of inter-firm transactions and interconnections of logistics requires sufficient data security. The importance of IT security is also emphasized by the fact that digitization and interconnection pave the way for large value creation systems that can easily be destabilized by cyber-attacks especially in the logistics area (Birkel et al., 2019). The responsibilities and tasks of IT security management systems change from protecting large computer systems to protecting entire production systems and value creation networks. However, organizations lack knowledge in how to securely design value creation processes and how to ensure data security in Industry 4.0. For instance, companies tend to implement digital technologies without considering security vulnerabilities (Barreto et al., 2017). To minimize cyber risks, companies are asked to implement and use an effective and comprehensive IT security management system

(Tuptuk & Hailes, 2018). Due to a variety of available security measures and control mechanisms, it is important to balance costs and benefits to find an individualized solution (Häckel et al., 2018). Interconnection and digitization enable systems to control decisions and processes in real time, which results in enormous amounts of data that have to be managed properly. Difficulties also stem from the characteristics and quality of the data masses generated by different objects and systems which in turn leads to strong data heterogeneity. Thus, heterogeneous data from different sources must be managed within the data management analysis (Jiang et al., 2018; Schmidt et al., 2020).

Table 1 Structure of the empirical data and scientific literature

Topcode[a]	**Subcode[a]**	**Categories**	**Exemplary References**
Suppliers & partners (13)	Critical attitude towards changes (5)	New processes, new suppliers, incentives and stimuli, convincing	Fernandez-Carames & Fraga-Lamas, 2018; Müller et al., 2020; Veile et al., 2020
	Refusal of data transparency (3)	Lack of data sharing readiness, fear of transparency, conserving competitive advantages	
	Dependency (5)	Reliance of suppliers, dependencies on customers, fear of monopolies	
Organization & Implementation (12)	Investment volume (7)	Large investments, large projects, missing propensity to invest, long and unclear duration of amortization	Birkel et al., 2019; Illa & Padhi, 2018; Müller et al., 2020
	Status Quo (2)	Excessive demands for suppliers, disadvantaged SMEs, sector-dependent characteristics	
	Lack of expertise and resources (3)	Lack of knowledge and skills, lack of resources	
	Internal harmonization (2)	Harmonizing internal processes, unifying data flows, consolidating master data	
Data management (10)	Data security (9)	Cyber-attacks, access permissions, data security, data abuse	Barreto et al., 2017; Birkel et al., 2019; Häckel et al., 2018; Tuptuk & Hailes, 2018; Rahman et al., 2020
	Data quality (3)	Ensuring data quality, master data	
	Data availability (1)	Availability of data	
Human aspects (8)	New employee roles (5)	Information, qualifications, skills	Birkel et al., 2019; Johansson et al., 2017; Müller, 2019; Robla-Gomez et al., 2017; Simons et al., 2017
	Labor market upheavals	Polarization of labor markets, quantity of jobs, skill level	
	Critical attitude towards changes (4)	Fear, concerns, doubts	
	Fear of job loss (2)	Fear of losing jobs	

Technology (7)	Implementation [b]	Data availability, technical issues, flexibility	Wuest et al., 2016; Müller et al., 2020
	Technology projection (3)	Overestimation of technology, uncertain technology forecast, wrong assessments	
	Immature systems (3)	Establishment of IT-providers, immature processes and systems, uncertainties	
	Choosing adequate solutions (2)	Lack of information transparency, lack of resources, financial burden, time	
Legal issues & standards (5)	Public framework conditions (3)	Digital infrastructure, legislation and legal conditions	Bonilla et al., 2018; Birkel et al., 2019; Müller et al., 2020; Saniuk & Saniuk, 2018
	Standardization (2)	Lack of standards and unified interfaces, definition of standards, harmonizing interfaces	
	Business ethics[b]	Regulatory interferences, avoiding global inequalities, social reactions	

[a]Multiple namings possible, mentions (out of 17 interviews); [b]not mentioned in interviews

Human aspects

Industry 4.0 does not only have the potential to change production technologies and processes within the value creation chain, but it also places employees in the logistics area in new contexts (Johansson et al., 2017). The term "operator 4.0" summarizes the need for a new generation of well-trained and skilled employees who cooperate with machines and systems (Garrido-Hidalgo et al., 2018). This requires comprehensive approaches to further develop employees and qualify them for Industry 4.0 (Müller, 2019). (Re)qualifying employees, for example regarding their technical understanding, interdisciplinary and analytical skills, however, brings new challenges (Simons et al., 2017). An awareness of the opportunities must be created to enable employees to collaborate with machines and to increase technology acceptance (Robla-Gomez et al., 2017).

These changes pose the potential to reshape entire labor markets (Johansson et al., 2017). Some authors additionally discuss an increasing polarization of labor markets in industrialized nations. For example, the number of jobs requiring medium qualifications declines, whereas the number of jobs for highly qualified skilled workers and low-skilled assistants increases (Birkel et al., 2019).

Technology

Vertical and horizontal integration pose major problems for companies in terms of technological implementation. The vertical integration of different companies and corporate functions does only succeed if data is available throughout the entire system, as this represents the only way to ensure real-time flexibility and transparency in logistics' processes (Müller et al., 2020). An additional horizontal interconnection and integration of upstream and downstream stages reinforce this effect following a greater complexity.

Handling technologies themselves is a further obstacle. Projecting their characteristics and usability is difficult and can be either overestimated or wrongly assessed. Following Industry 4.0's evolutionary character, digital technologies are constantly developing and using immature and fast developing systems can be pitfalls as well. In addition, adequately using the technologies is a challenge. For example, it is difficult to implement artificial intelligence for analysis purposes in logistics and to interpret results (Wuest et al., 2016).

Legal issues and standards

The cooperation of different companies in a value creation chain in the context of Industry 4.0 implies challenges with regard to contractual framework conditions. These include the cooperation itself, but also the responsibilities for data protection and liability issues. With an even greater influence the same does apply in international cooperation and cross-border data traffic (Horváth & Szabó, 2019; Saniuk & Saniuk, 2018).

In this regard, Birkel et al. (2019) address the importance of data protection. As a solution to the data protection problem, the authors propose legal regulations for technical solutions, such as clarifying data ownership on platforms or secure data transmission.

Bonilla et al. (2018) state that the long-term implications of Industry 4.0 are influenced by societal reactions, legal framework conditions and political decisions. To implement Industry 4.0 on a global level, technologies should be homogeneously distributed internationally in order to avoid inequalities between companies and economies.

CONCLUSION AND CONTRIBUTION

Technological progress and the digital transformation of industrial value creation reshape companies, value creation chains, and economies in the context of Industry 4.0. The digitization and interconnection of a value creation chain bring promising opportunities and potentials. However, associated challenges, and risks are to be regarded and taken into account in the same manner. Research lacks an analysis of challenges in logistics.

The aim of our study was to develop a comprehensive understanding of this topic, analyzing qualitative-empirical data and scientific literature. In the course of the study, 17 interviews with experts from German industrial companies and 69 scientific articles were analyzed and discussed. Following the study's results, challenges and risks for logistics include suppliers and partners, organization and implementation, data management, human and technological aspects, and legal issues and standards.

Challenges stemming from the *suppliers and partners* represent the most important. Interconnecting several companies is a complex task given various status quos regarding technological developments, resource availability and knowledge, and a lack of willingness to cooperate and share information. This calls for adequate strategies to set incentives and stimuli in order to encourage suppliers and partners to cooperate.

For the category *organization and implementation*, challenges arise regarding the technical implementation, strategic decisions, and economic considerations. The selection of hardware and software, a fusion of the virtual and real worlds, and vertical and horizontal integration brings pitfalls from a technical point of view. Successful implementation requires adjustments as for processes and organizational structures. With regard to economic aspects, both the empirical data and literature highlights the difficulty of investment decisions under uncertainty, availability of investment resources and excessive transaction costs, and unclear amortization and profitability.

As far as *data management* is concerned, the results unveil challenges for data security, availability and integrity of data, and data quality. Open systems, interfaces, and countless interconnections increase the vulnerability of processes and systems asking for sufficient data security. Further, companies face the challenge of using an enormous amount of heterogeneous data from different sources for real-time-based evaluation and for the automated optimization of processes. Properly managing this data and integrating data analyses into existing business practices and processes is a critical factor. Characteristics such as confidentiality, availability and integrity of data and systems must be considered as decisive factors in security management.

In terms of *human aspects*, the empirical data and literature emphasize that the role of employees, their work environment, and framework conditions evolve. The qualification of people focuses on technical, interdisciplinary and creative skills and competences. Companies are ought to find approaches to qualify employees, strengthen the acceptance of changes, build up sufficient awareness, and create common visions.

The interconnection of logistics in the context of Industry 4.0 poses *technical challenges* with an even greater complexity in the horizontal interconnection with suppliers. Further, implementing and using digital technologies may be an obstacle given fast-developments, lack of information transparencies, and unclear outcomes.

Last but not least, as for *legal issues and standards*, the results show that a smooth integration and system implementation is hampered by a lack of norms and standards. In addition, technological progress calls for further developing legal framework conditions for system security and data protection. Companies need to create new contractual bases that enable international cooperation in the context of Industry 4.0.

Research and practical implications

The paper analyzes the challenges and risks that Industry 4.0 brings especially for logistics, and in so doing, extends the current scientific understanding. Thereby, it contributes to research providing empirical insights and presenting the state of research on the challenges of Industry 4.0 from a logistic lens and adds to the academic discussion. The study can serve as a starting point for further in-depth qualitative analyses and also quantitative research studies shedding light on this topic.

Managers and corporate practice may benefit from the results, as challenges are highlighted in the context of Industry 4.0 that can be referenced to individual companies and supply chains alike. Deepening the understanding of challenges, may help to better grasp the challenges, perceive them at an early stage, and address them proactively.

Limitations and further research

The paper's methodology entails some limitations. For instance, the article selection and the classification base on certain subjective assessments. Given restrictions, e.g., regarding the accessibility of articles and choice of databases, it remains unclear whether further publications might be worth analyzing. As far as the interviews are concerned, the choice of experts and industry sectors, biases during the interview process, and subjective influences during the analysis might distort the results.

The results of the study provide a basis for future research. Expert interviews of further related industry sectors and quantitative analysis could represent next steps to analyze challenges of Industry 4.0 for logistics. Based on our results and on the further research, best practices can be developed for a successful implementation and management of Industry 4.0 in the logistics area.

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Investigating the Barriers of the Internet of Things implementation in the automotive supply chain in Egypt

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Abstract

Purpose of this paper:
Technology is quickly evolving in nearly all business sectors. Smart technologies and the Internet of Things (IoT) are changing the ways global logistics and supply chains are managed especially in times of uncertainty. Thus, the readiness of all supply chain partners is of prime importance to sustain the competitiveness of supply chain networks. This research aims to investigate the barriers which might hinder the implementation of IoT in the automotive supply chain in Egypt. The automotive sector is one of the most important sectors in the Egyptian economy and the adoption of IoT would positively impact the performance of its supply chain.

Design/methodology/approach:
This research is qualitative in nature as IoT is a novel topic in the Egyptian business community and this would require a thorough investigation and examination of insights from multiple stakeholders. This empirical study employs a qualitative methodology to investigate the barriers to IoT implementation in the automotive supply chain in Egypt in addition to provide recommendations to overcome such barriers. Data is collected through semi-structured interviews with industry experts in the automotive supply chain in Egypt. Data is analysed by interpretive structural modelling (ISM) to develop a structured model representing the possible interrelationships between the IoT barriers implementation in Egypt and MICMAC analysis.

Findings:
The ISM model for the IoT implementation barriers in the automotive SC in Egypt was found to comprise four hierarchical levels. The lack of regulations and policies, and the lack of technical knowledge among supply chain partners are the key barriers to IoT implementation. The MICMAC analysis revealed that the IoT implementation barriers are categorised into 2 the linking and driving cluster.

Value:
This research attempts to fill the gap in supply chain management and technology applications research in Egypt. It supports researchers and academics in future research. It also assists the business sector in understanding the barriers involved in IoT implementation in Egypt.

Research limitations and implications:
This research is limited to the automotive sector in Egypt. Future research can address more stakeholders in the automotive supply chain.

Practical implications:
This research is an attempt to draw the attention of the business sector towards IoT. It can also encourage policy makers to take positive initiative into facilitating the introduction and adoption of IoT in the business sector.

Keywords:
Internet of things, automotive, supply chain, Egypt, barriers

1. INTRODUCTION

Technological innovation is an essential component of today's business environment. It is viewed as a key enabler to sustain competitive advantage in the global supply chain networks. Without technology integration, supply chains (SC) would risk market shares, profitability, resources optimization, flexibility and resilience. The global disturbance that the world has witnessed with Covid19, has taught businesses around the world the importance of processes/network visibility. This visibility cannot be achieved without the right technology integration into the SC processes.

Industry 4.0 (I4.0) introduced a range of technologies that positively influenced the visibility, agility and responsiveness of SC processes (Schumacher et al., 2016). Industry 4.0 as Tortora et al. (2021) defined it, is "the recent technological advances where the internet and supporting technologies serve as a backbone to integrate physical objects, human actors, intelligent machines, production lines and processes across organizational boundaries to form a new kind of intelligent, networked and agile value chain". These technologies include cloud computing, automation, predictive maintenance, internet of things (IoT), simulation, additive manufacturing, augmented reality, big data and analytics (Schumacher et al., 2016).

The implementation level of the I4.0 technologies significantly varies across countries and industries, and research has shown that emerging and developing economies are not on the same I4.0 development momentum as the developed economies (Sharma et al., 2020; Kamble et al., 2019).

To catch the I4.0 development momentum, Egypt established a series of policies and regulations to support the digitization of the public and private sectors since 2016. The country witnessed a remarkable information and communication technology (ICT) infrastructure development. However, the implementation of IoT in the business sector remained weak. Therefore, this research investigates the barriers of IoT implementation with a focus on the automobile supply chain in Egypt. The automobile sector was selected as the empirical study because it is one of the vital business sectors in the Egyptian economy and it would significantly benefit from IoT implementation. The automobile SC is known with its sophisticated tiers of suppliers in the upstream networks, numerous parts/inventories and long transport journeys which result in lack of visibility and difficulties in planning. The implementation of IoT can thus support in overcoming these challenges and support the competitiveness of this sector.

This research starts with a literature review on the IoT in supply chain management (SCM) and the barriers of its implementation. The research then identifies the barriers of IoT implementation in the automotive sector in Egypt and establishes the interrelationship between the barriers through the ISM methodology to rank these barriers in terms of importance.

2. LITERATURE REVIEW

2.1 Internet of Things (IoT) in Supply Chain Management

IoT became the buzzword in the last few years as businesses rushed to utilize this new technological platform which uses big data and predictive analysis to increase productivity and profitability (Kamble et al., 2019). According to Baldini et al. (2018), IoT is based on the idea of connecting "things" through error-free networks regardless of its locations, motions and time. IoT simply connects software, electronics and sensors into "things" i.e., devices to collect and exchange data through the internet (Zhou et al., 2015). This in return promoted the agility of manufacturing and efficiency among stakeholders (Kamble et al., 2019; Khan et al., 2018). Additionally, IoT supports risk mitigation as it promotes transparency, traceability, and flexibility (Zhou et al., 2015).

IoT plays a significant role in supporting SC integration, a key criterion to SC competitiveness and resilience (de Vass et al., 2020; Vanpoucke et al., 2017). Shee et al. (2018) described SC integration as the synchronization of internal and external business processes through the material, information and monetary flows to achieve a higher

customer value rapidly and efficiently. Supply chains with robust integration has improved decision making as processes are visible and traceable (de Vass et al., 2020; Reaidy et al., 2015). Thus, IoT enables the digital integration between the upstream and downstream SC processes, resulting in better planning and coordination among SC partners.

Many researchers studied the benefits and applications of IoT in SCM. A study by Mckinsey (2015) predicted that the applications of IoT in SCs will achieve an average economic inflow of $7.5 Trillion a year by 2025. Ellis et al. (2015) showed that IoT enables SCs to achieve unprecedent responsiveness and agility as supply chains can react to changes in real time. This in return results in delivering more customized and innovative customer service as IoT integrates inventory management and the downstream processes that involve distribution centres, transportation, and customer management system (Parry et al., 2016; Zhou et al., 2015). Maksimović et al. (2015) studied the application of IoT in the food SC. Their research proved that IoT provided low-cost real-time food traceability and monitoring from farm to the final point of consumption. The findings of De Vass et al. (2020) in the retail sector confirmed the ability of IoT to integrate SC processes as it enables "data auto-capture (automation), visibility (real-time), intelligence (real-time insights) and improved communications internally and externally with business partners". Their study also showed that IoT has a positive impact on the environmental sustainability of the retail sector as operations became paperless, consumed less energy, reduced waste and carbon footprint (de Vass et al., 2020).

2.2 Internet of Things (IoT) in the Automotive Supply Chain

Research on IoT in the automotive industry is highly varied as researchers examined the application of IoT in the automotive SC processes while others examined its applications on the automotive end-users i.e., customers (Rahim et al., 2020; Sharma and Kaushik, 2019; Silva et al., 2019; Han-jiang and Fang, 2013). In the automotive SC IoT can be used in demand forecasting, manufacturing, real-time materials handling, logistics scheduling and tracking, spare parts inventory management and after-sales services (Rahim et al., 2020). IoT can easily facilitate the transfer of this enormous amount of data which in return supports decision making along the SC.

Bandyopadhyay and Sen (2011) showed that the use of radio frequency identification (RFID) within the IoT system in the automotive SC improved logistics, increased quality control, streamlined production and improved customer service. The automotive parts with RFID tags contain information such as product type and code, serial number, the name of the manufacturer, date, and location of production (Bandyopadhyay and Sen, 2011). In addition, RFID tags enable real-time data transmission in the manufacturing process and allows a more effective way to manage recalls.

Han-jiang and Fang (2013) discussed the automotive materials procurement, an extremely popular challenge in the automotive SC, and how IoT with collaborative planning, forecasting, and replenishment (CFPR) would support the suppliers and manufacturers in more efficient and rapid procurement cycle. Ljung and Capadrutt (2020) studied the role of IoT in creating visibility and connectivity in the end-to-end automotive SCs and how it impacts SC performance. They specifically discussed IoT technology's ability to detect early abnormalities in the SC process like delays that might impact production lines. They also discussed the challenge of the reverse logistics flow of packages, pallets and containers that need to be returned to suppliers for reuse. Automotive manufacturers will benefit from IoT applications in this reverse flow as it will easily gather information on the location, sizes and amount of packaging to be returned resulting in an optimized and more sustainable flow (Ljung and Capadrutt, 2020).

Rahim et al. (2020) also pointed a very vital element in the automotive industry which is the after-sales service. They stated that the implementation of IoT technology can track the vehicles performance, collect feedback from customers and thus the automotive manufacturers can introduce improvements in future vehicle design and specifications.

2.3 Barriers to IoT Implementation

Research has shown that the implementation of IoT technology is challenging and its integration into the business eco-system is still emerging (de Vass et al., 2020; Rahim et al., 2020; Vanpoucke et al., 2017). Table 1 presents a summary of the IoT implementation barriers based on previous literature.

Barrier	Description	Author(s)
Incompatible IT infrastructure	Existing discrepancies between IT infrastructure and architecture.	Kamble et al., 2019; Aikaterini, 2014
Lack of regulations and policies	The absence of a robust legal framework increases the probability of incorrect actions.	Dhingra, 2016; Hannan et al., 2015
Security and privacy	Poorly secured connections may result in data piracy and lack of confidentiality.	Caro and Sadr, 2019; Birkel and Hartmann, 2019
Reluctance to invest in IoT	IoT requires a high upfront investment with long payback periods.	Rejeb et al., 2020; Huang et al., 2019; Lee and Lee, 2015
High operational cost	High operational cost of smart devices installation and workforce training.	Rejeb et al., 2020; Sharma et al., 2020
Limited skilled workforce	The lack of available technical staff who can operate and manage the IoT system	Kamble et al., 2019; Talavera et al., 2017
System failure	Server's crash or failure can seriously impede the IoT system	Farooq et al., 2015
Lack of technical knowledge among supply chain partners	Lack of IoT awareness and knowledge among the supply chain network partners.	Sharma et al., 2020; Aikaterini, 2014
Insufficient internet connectivity	Poor internet connectivity in many locations that do not have proper internet network coverage	Sharma et al., 2020; Sun et al., 2010

Table 1 – IoT Implementation Barriers

Therefore, it was evident from the literature that the implementation of IoT has a positive impact on SCM and on the automobile SC specifically. Additionally, the literature revealed that there are barriers to implement IoT technologies in the SC as shown in Table 1. The literature review also showed a lack of studies that addressed the topic of IoT in SCM in Egypt. Thus, this research aims to investigate the relationships between the barriers of IoT implementation in the automobile sector in Egypt and their influence on each other to provide a structured model for interrelationships between the barriers.

3. RESEARCH METHODOLOGY

This research follows a qualitative approach in which Interpretive Structural Modelling (ISM) is used to identify the relationship among the IoT implementation barriers in the automotive SC in Egypt. The ISM technique supports the identification of the dominant and most influential IoT implementation barriers and in return recommendations can be made to overcome such barriers in Egypt. ISM was used by many researchers who investigated the IoT implementation barriers (Sharma et al., 2020; Singh and Bhanot, 2020; Kamble et al. 2019). ISM mainly depends on the opinion of experts to decompose complex variables and relationships into a simple multi-level structural model (Kamble et al., 2019; Mathiyazhagan et al., 2013). The ISM technique involves multiple steps as suggested by Warfield (1974) and followed by (Singh and Bhanot, 2020; Kamble et al., 2019; Mathiyazhagan et al., 2013):

Step 1: The IoT implementation barriers are identified from the literature review and validated by the experts

Step 2: A structural self-interaction matrix (SSIM) is developed to show the pair-wise relationship among the barriers. Four symbols are used to present the direction of the

relationship between the IoTBs (i and j): **V** (i influences j), **A** (j influences i), **X** (i and j influence each other), and **O** (no relation)
Step 3: Develop the initial reachability matrix by converting the symbols V, A, X and O used in SSIM into binary values 0 and 1 according to the rule described in Warfield (1974).
Step 4: The final reachability matrix which incorporates the transitive relations among barriers is developed based on the following: if a barrier **M** is related to **N** and **N** is related to **P** then **M** is similar to **P**.
Step 5: The reachability, antecedents and intersection sets are derived from the previous step to reach the level partitions of the barriers and create the ISM.
To further analyze the barriers, the MIMAC analysis is used to investigate the driving and dependence power of each variable.

DATA ANALYSIS
As the research focuses on the automobile SC in Egypt, a panel of 14 experts was selected to participate in the study: 5 automotive assembling factories, 3 dealerships, 2 service centers and 4 suppliers. The experts were supply chain managers, I.T. managers, operations managers, and production engineers with more than 10 years' experience in the field of automotive. To validate the list of barriers from the literature (Step 1), the panel of experts was asked to identify the level of importance of these barriers to the automobile SC in Egypt using the scale of low, moderate, and high as shown in Table 2.

Barrier		Importance
B1	Incompatible IT infrastructure	High
B2	Lack of regulations and policies	High
B3	Security and privacy	High
B4	Reluctance to invest in IoT	High
B5	High operational cost	High
B6	Limited skilled workforce	Moderate
B7	System failure	High
B8	Lack of technical knowledge among supply chain partners	High
B9	Insufficient internet connectivity	Moderate

Table 2 – The Importance Level of IoT Implementation Barriers

As shown in Table 2, the experts indicated that the majority of the barriers are of high and moderate importance which validate the list of barriers for further analysis. To develop the SSIM in Step 2, the experts were asked to indicate the influence of barriers on each other to create the pair-wise relationships as shown in Table 3.

	B9	**B8**	**B7**	**B6**	**B5**	**B4**	**B3**	**B2**
B1	V	O	V	O	O	A	V	O
B2	O	O	O	O	V	V	V	
B3	A	A	A	A	X	V		
B4	A	A	V	V	A			
B5	A	A	A	A				
B6	O	A	V					
B7	A	A						
B8	V							

Table 3 – SSIM of IoT Implementation Barriers in the Automotive Supply Chain

In Step 3 and 4, the initial reachability matrix is created and then the final reachability matrix is developed by applying the transitivity rule as previously described in the ISM methodology. In Step 5, the reachability, antecedents, and intersection sets are derived from the previous step to reach the level partitions. The hierarchical levels indicate the relationship between the IoT implementation barriers. If the reachability and intersection sets are the same, then the barrier is the top level of the model. In ISM methodology, the

top level does not result in any barriers above its level. Iterations are then conducted to find the new levels in the hierarchy. As shown in Figure 1, the IoT implementation barriers in the automotive supply chain in Egypt consists of four hierarchical levels.

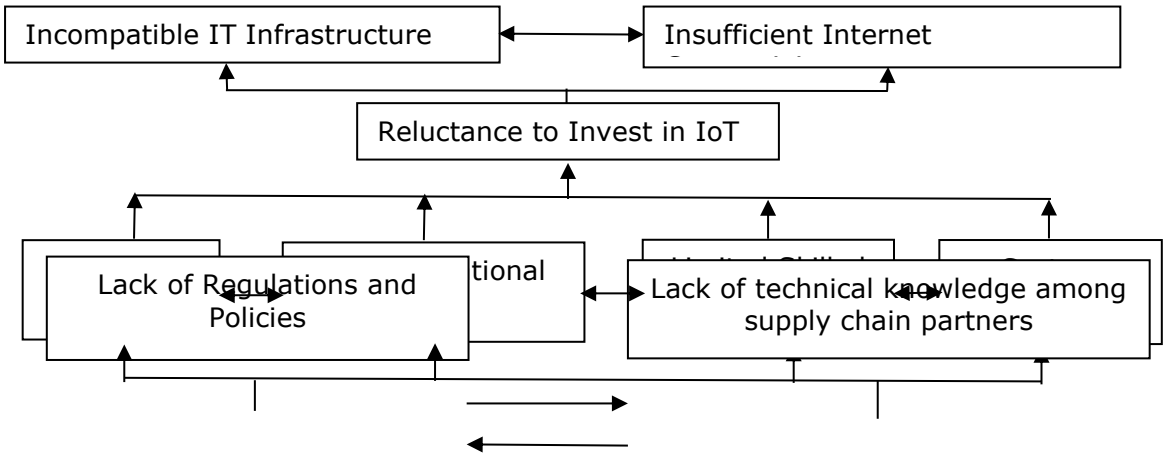

Figure 1- ISM Model for IoT Implementation Barriers in the Automotive Supply Chain

The ISM model demonstrates the dependency relationship between the IoT implementation barriers in the automotive supply chain in Egypt. As shown in Figure 1, incompatible IT infrastructure (B1) and insufficient internet connectivity (B9) are the top barriers to IoT implementation at level 1 and they are driven by three hierarchies. At level 2 is reluctance to invest in IoT (B4) which is driven by four barriers in level 3. These four barriers are also affecting each other at level 3: security and privacy (B3), high operational cost (B5), limited skilled workforce (B6) and system failure (B7). Level 4 consists of two barriers: lack of regulations and policies (B2) and lack of technical knowledge among supply chain partners (B8). These two barriers are the most important barriers as they drive the existence of the other barriers and thus, they are the key IoT implementation barriers in the automotive SC in Egypt.

The MIMAC analysis is used to investigate the driving and dependence power of each variable by categorizing the barriers into 4 clusters: autonomous, dependent, linking and driving as shown in Figure 2. The findings show that the autonomous cluster (cluster 1) which presents the barriers of low dependence and low driving power did not include any IoT implementation barriers. This in return shows that all the barriers in this study are relevant and connected. The dependent cluster (cluster 2) which presents the barriers of high dependence power and low driving power did not include any barriers as well. The linkage cluster (cluster 3) is very vulnerable because the barriers in this cluster have high dependence and high driving power. Therefore, any changes in these barriers will impact the barriers at the other levels as well as impact themselves. The IoT implementation barriers in this cluster are incompatible IT infrastructure (B1), security and privacy (B3), reluctance to invest in IoT (B4), high operational cost (B5), limited skilled workforce (B6), system failure (B7) and insufficient internet connectivity (B9).

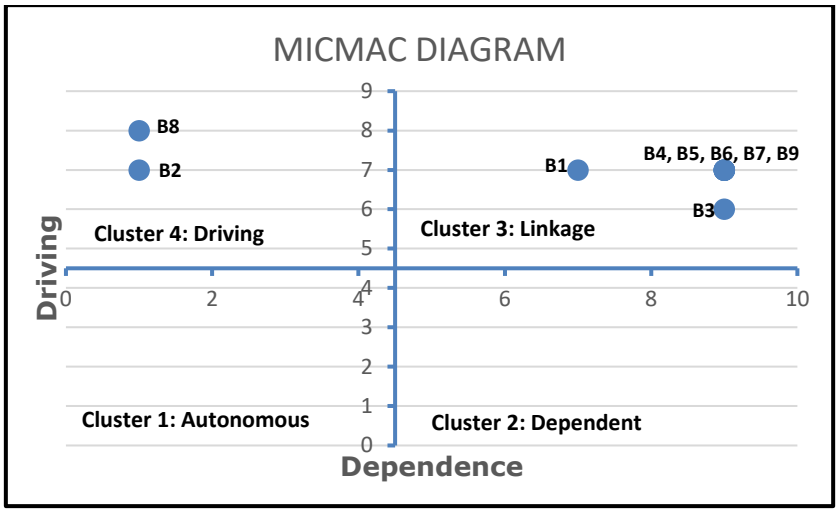

Figure 2 – MICMAC diagram for IoT implementation barriers

These barriers are extremely volatile and prevent the implementation of IoT in the automotive SC in Egypt. The barriers in the driving cluster (cluster 4) have low dependence and high driving power, and it includes lack of regulations and policies (B2) and lack of technical knowledge among supply chain partners (B8). These two barriers are the main IoT implementation barriers in the automotive SC in Egypt. Therefore, special attention should be given to these barriers as any introduced changes will have an effect on all the other barriers at all hierarchical levels.

DISCUSSION AND CONCLUSIONS

The integration of technology is crucial to maintain SC competitiveness and data-centric SC will be dominating the market. Previous research showed that the integration of technology faces various implementation barriers which make the process complex and challenging. IoT technologies will soon become the norm of the business environment and it is thus crucial to start examining the barriers to its implementation in the business sector in Egypt. The study focused on the automotive SC to understand the relation between the barriers that impede the implementation of IoT as an initial step to achieve their elimination or reduce their intensity to support practitioners in IoT implementation. The study showed that the 'lack of regulations and policies' and 'lack of technical knowledge among supply chain partners' are the principal barriers for IoT implementation in the automotive SC in Egypt. The existence of regulations and policies by the government creates some pressure on the business sector to initiate implementation plans. Thus, the Egyptian government through its ministries and authorities should soon consider introducing regulations and policies on IoT technologies. In addition, the government can positively contribute to overcome the second barrier 'the lack of technical knowledge among supply chain partners' by creating educational initiatives for the business sector. These initiatives can include chambers of commerce, universities, and international experts to provide training and education on IoT technologies in addition to providing technical assistance for IoT implementation projects. This in return will also assist in overcoming the barrier of 'limited skilled workforce'. As for the technical barriers which include 'security and privacy', 'system failure', 'incompatible IT infrastructure' and 'insufficient internet', they could be reduced or eliminated through a robust IT strategy which includes detailed development phases to build the robust blocks of the IoT system. Lastly the financial barriers which include 'high operational costs' and 'reluctance to invest in IoT' can be addressed by allocating fund schemes that would encourage the business sector in integrating IoT technologies.

The contribution of this study is presented in filling the gap in academic literature on IoT implementation barriers in Egypt. The ISM model of the IoT implementation barriers in the automotive SC in Egypt contributes in providing SC practitioners with a guide to prioritize the barriers and initiate actions for their elimination or removal. Further research can be

done to study detailed solutions to overcome the barriers and validate the proposed ISM model in other business sectors.

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IOT-FRESHNESS SENSOR DATA-DRIVEN PRICE INFORMATION SYSTEM FOR FOOD WASTE REDUCTION IN GROCERY RETAIL STORES

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ABSTRACT

Purpose of this paper:
Bulk fresh fruits and vegetables at the grocery retail stores are being wasted dramatically as disrupted grocery supply chains produce more food waste than ever before. Perishable foods need to be sold out before reaching the expiry date. Furthermore, insufficient market prices are likely to result in food surplus/food waste in retailers. The purpose of this paper is to meet customers' quality and price requirements while minimising the food waste (disposal of produce) and increasing the profit of the retailer. The quality loss of a perishable item occurs naturally, and it becomes unacceptable by the customers as it stays on the shelves. Computational logistics applications such as hyperspectral imaging sensors can help grocery stores to reduce the food waste and increase profit by continuously inspecting the food quality and send signals to a computer that updates the unit price based on the freshness score and the remaining quantity of the product. This study explores the food waste reduction challenge by proposing an IoT freshness sensor data-driven four-stage price information system.

Design/methodology/approach:
In this paper, the food waste problem at the retailer stage is highlighted and an IoT freshness sensor data-driven four-stage price information system is proposed to reduce food waste by performing a pilot project for bulk apple sales. A multi-stage dynamic programming method is used to decide on a pricing strategy for the bulk produce, where real-time IoT sensor data retrieved from hyperspectral imaging sensors is employed to analyse and determine the length of freshness stages. Monte-Carlo simulation is employed to model the daily operation of a grocery store, and a numerical example is performed to illustrate the practicability of the proposed model.

Findings:

The model is simulated according to scenario-based and parameter effect analysis. Simulations were run to analyse the effects of sales price, the replenishment amount and the discount rate on profit and food waste and also effect of freshness score on profit and inventory level. The analysis show that these parameters have significant effects on the food waste of the grocery store.

Value:
The novelty part of this paper is to present a real-time IoT sensor data-driven dynamic model to decide pricing at different stages of a sales season at retailers in the perishable food supply chain for the first time, to the best of our knowledge, in a research work in the literature.

Research limitations/implications (if applicable):
In this research, freshness sensor data retrieved from hyperspectral imaging sensors is used to determine price strategy of produce and the Monte-Carlo simulation is conducted to model the daily operations of grocery store.

Practical implications (if applicable):
This proposed system is useful for the grocery stores to reduce their food waste, if any grocery supply chain disruption such as due to COVID-19 pandemics occurs.

INTRODUCTION

According to the Food and Agriculture Organization (FAO), nearly 1.3 billion tons of food, one-third of all food produced for human consumption is lost or wasted worldwide every year (FAO); in addition, fruits and vegetables have the highest wastage rates of any food products, and almost half of all fruits and vegetables are wasted (Kayikci et al., 2020). The term of food loss and waste (FLW) is commonly used to describe total losses and wastage, which can occur from farm-to-fork within the different stages of the food supply chain during farming, harvesting, post-harvesting, processing, handling and storage, transportation and distribution, retail and consumption stages (Parfitt et al., 2010; Vilarino et al., 2017). Food loss takes place mostly in the early and middle stages of the food supply chain (close-to-farm), whereas food waste occurs significantly at the later stages of the food supply chain (close-to-fork), namely at the consumer or household stages, but also at retailers, hotels, and restaurants.
Fresh produce is a perishable asset, which means it has a certain shelf-life. Perishable products should be sold out within a certain shelf-life range; afterwards, they would have no economic value at all. Furthermore, the current COVID-19 pandemic causes severe disruptions in the grocery supply chains because of sudden lockdowns and many fresh products remaining unsaleable and result in huge food waste problems. On the one hand, food waste caused by unsold food products at retail must be minimized to achieve sustainability (Kayikci et al., 2020); on the other hand, improving customer satisfaction through the delivery of good quality products in the right quantities with an optimal price strategy is the primary objective of the most grocery retail stores (Validi et al., 2014). Here, the food price needs to meet the freshness level of produce. Therefore, there is a need to develop a pricing strategy for the freshness level of produce.
Recent developments in food traceability systems minimize the possibility of low-quality food production and distribution and help food supply chains improve customer service levels (Aung and Chang, 2014). The Internet of Things (IoT) technology-based food traceability systems provide the best solution to reduce food waste along the food supply chain (Al-Turjman, 2017). Sensors as IoT-enabled devices help retailers monitor food status (e.g., freshness level or degradation) and measure changes on the food products and provide an overall estimation of food quality. Also, an IoT-driven pricing system leads to achieving a service level such as price discrimination according to the freshness status of food products. Therefore, retailers that employ IoT-sensor data-driven pricing strategy might better monitor and manage the trade and remaining saleable life of perishable products on shelves while reducing food waste.
In this study, the food waste problem at the retailer stage is highlighted, and an IoT-freshness sensor data-driven four-stage price information system is proposed to reduce food waste by performing a pilot project for bulk apple sales. Monte-Carlo simulation is employed to model the daily operation of a grocery store. The simulation of this research addresses the following research questions: RQ1: What is the effect of IoT-freshness sensor data-driven control systems on food waste at retail stores? RQ2: How do IoT-freshness sensor data-driven control systems reduce food waste by dynamically updating sales prices? The rest of the paper is structured as follows: first, a brief overview of the food waste reduction with IoT-freshness sensors is provided. Then, the proposed IoT-freshness sensor data-driven price information system is described in more detail. Afterward, a numerical analysis is performed to show the applicability of the proposed system and to gain managerial insights. Finally, the conclusion of this study, implications, and future research are presented.

FOOD WASTE REDUCTION WITH IOT-FRESHNESS SENSORS

Food sustainability and waste are considered a global challenge in most developing countries. However, the advancement of new technologies might help to resolve this challenge. The applications of IoT-sensor technology, radio-frequency identification (RFID), machine vision, data analytics are reshaping food supply chains and food strategies from farms to grocery retail stores to enable stock visibility, monitor and reduce food waste and increase sustainability. At retailer stages, a combination of these technologies can be employed to offer variable pricing strategy to customers based on shelf-life (freshness level) of produce; this would be beneficial to save the large amounts of money caused by food waste. In particular, IoT-sensors collect real-time data about the status of fresh produce for freshness monitoring, quality inspection, temperature measurement, and ripeness within a shelf-life range to set the right pricing strategies. There are several sensor types and technologies in the retail stages of the food supply chain. These sensors, such as light sensors, colour sensors, temperature sensors, electromagnetic sensors, biosensors, ultrasonic sensors, optical sensors, and gas sensors, can vary depending on the area of use, capabilities, and functioning (Holm, 2005; Sangeetha and Vijayalakshmi, 2020). They can be utilized during retail stages to prevent food spoilage (i.e., biological and chemical contamination) and dumping.

A freshness sensor generally informs users regarding the status of food products in terms of quality (e.g., freshness level) and safety standards. Increasing demand for fresh, high-quality, and safe foods with longer shelf-life urges retailers to use freshness sensors in their grocery retail stores. This need increases further due to the health and safety concerns caused by COVID-19, as urban food systems are also highly vulnerable because of the coronavirus outbreak. Consumers' interest in knowing the ingredient and components of products, packaging information, and storage conditions increase the need for freshness sensors during the food packaging operations (Kuswandi, 2017). Both retailers and customers can monitor the quality of a fresh product through the food sensors used in smart packaging. A time-temperature indicator (TTI) is a smart label that shows the accumulated time-temperature history of a product, and it is the simplest form of smart packaging. Food quality can be analysed using more sophisticated indicator sensors by monitoring different organic compounds, such as ethanol, glucose, or gas molecules, and measuring bacterial content, contamination, texture or colour degradation, and bruising (Pal and Kant, 2018). The sensors form different case technologies for detecting edible produce for providing a better shelf-life (Holm, 2005; Sangeetha and Vijayalakshmi, 2020). Monitoring the level of freshness can increase the need for fresh, high-quality, and safe foods with a longer shelf-life. For instance, one of the optical sensors, hyperspectral imaging, has a better capability to get more information about freshness and demands higher storage requirements to monitor produce frequently (Sangeetha and Vijayalakshmi, 2020).

This study takes the hyperspectral imaging sensor into consideration, an emerging technology that combines image information and spectral information to visualize and analyse the internal and external characteristics of food products. Moreover, hyperspectral imaging technology is widely used in the quality inspection of agricultural products, such as identifying hidden bruises on kiwi fruit, internal injury in almond nuts, common defects in jujube, and black spots potatoes (Tan et al., 2018). Hyperspectral imaging has special cameras that can detect the molecular changes in the food product through wavelengths (400-1000 nm), indicating its freshness level or whether it was previously frozen (Hagen, 2018). It can also detect the remaining time of a food product before it reaches the end of the shelf-life.

To the best of our knowledge and after reviewing the existing literature in the field of food supply chain and food waste, no research is conducted to propose a pricing model that uses real-time IoT-sensor data to apply a dynamic pricing strategy to reduce food waste at retailer phases. In addition to that, studies that employ real-time IoT-data are concerned with the shelf-life of fresh produce in terms of outside factors such as temperature, humidity, contamination, bacterial content, and so on. Furthermore, no papers analyse the shelf-life by considering the freshness level of produce under the multi-stage price setting. To fill the gap mentioned above, this study introduces a novel four-stage price information

system to decide on the pricing strategy for bulk fresh produce at the grocery retail stores by integrating real-time IoT-freshness sensor data, which analyses and determines the length of the freshness stages in the pricing system.

IOT-FRESHNESS SENSOR DATA-DRIVEN PRICE INFORMATION SYSTEM

In this study, an IoT-freshness sensor data-driven pricing system employing a four-stage pricing strategy by using real-time hyperspectral imaging sensor data to measure the freshness level of produce is proposed to solve the food waste problem for bulk-buying consumers in the grocery retail stores. This paper focuses on bulk produces since the consumers in the developing countries usually buy bulk produce instead of packaged produce. The proposed pricing system comprises four pricing stages, namely: (i) freshness stage, (ii) cheaper stage, (iii) redistribution stage, and (iv) disposal stage.
The proposed system with timeline, stages, and associated information system infrastructure is demonstrated in Figure 1. The freshness level is taken into account in each stage, and the hyperspectral imaging sensors will measure this level. The explanation of these pricing stages are as follows:
Stage 1 - Freshness Stage: It is assumed that the demand (D) of the produce is based on the freshness level of produce obtained through real-time sensor data acquisition. The selling season at Store 1 begins with the replenishment of the bulk produce. The grocery store receives the demand signal based on the freshness level of produce and sets the initial selling price (p_1), under the unit purchase price (c_0). Stage 1 is characterized by a 100-80% freshness level of produce, which means that the product will be categorized at the "freshness stage" and the price will not be updated unless the freshness score is not less than 80%. This also shows the length of the pricing period for (t_1). During this stage and subsequent stages, which are not necessarily equal in length, the store can update the unit price of produce as it becomes necessary. It is assumed that the length of each period depends on the rate of decay of the produce, and the grocery updates the unit price dynamically based on the freshness level of produce. Here, the IoT-sensor data is aggregated in real-time and processed to automatically determine the freshness level of produce with edge computing. Edge computing also enables the transfer of real-time generated pricing information to the store's local Enterprise Resource Planning (ERP) database in order to issue work orders to change the price in the whole store, including RFID/barcodes, electronic shelf labels, and payment points. This part is seen in *Section I* in Figure 1. Furthermore, changing prices are transferred to the cloud system of grocery retailer central through IoT-gateway, and from there, they are distributed to ERP and Customer Relationship Management (CRM) systems, as seen in *Section II* in Figure 1. This process is repeated in other pricing stages as well.

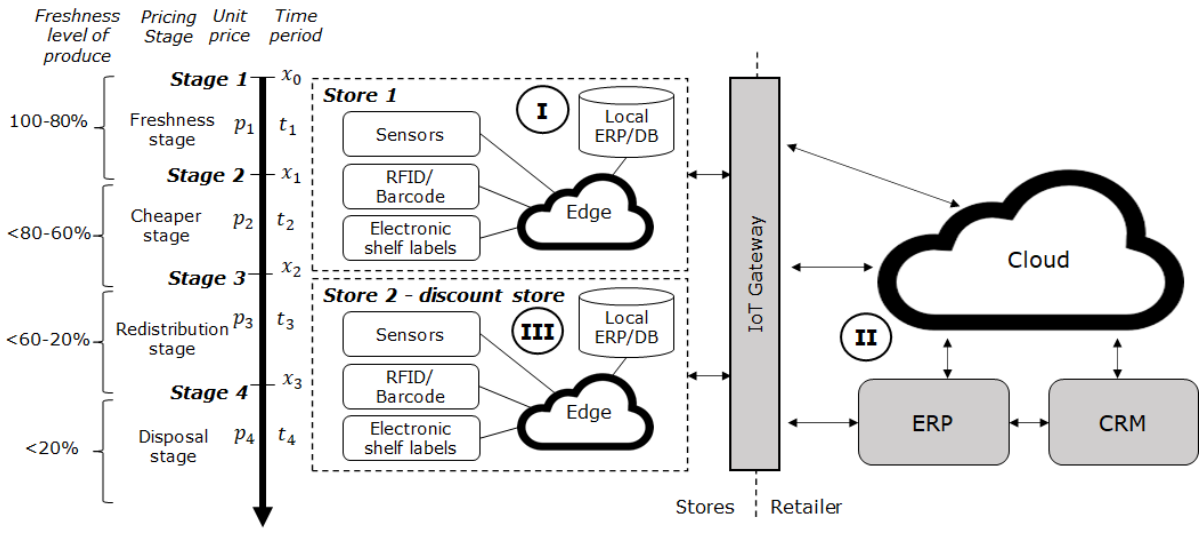

Figure 2: IoT-sensor data-driven price information system in the grocery retail stores

Stage 2 - Cheaper Stage: As the produce becomes less fresh, the grocery reduces the unit price to make it more appealing to the consumers. At the beginning of Stage 2, the store updates the unit price based on the on-hand inventory since this is the last chance to sell the remaining produce in the same store before the redistribution stage. During this stage, the produce is less fresh but still edible. Since only (t_2) period of time left to the redistribution stage, grocery is expected to set a unit selling price, $p_2 (p_2 < p_1)$ to deplete stocks to prevent food waste. Since the quality of produce will be lower, and the grocery will incur an additional distribution cost in the next stage, the profit margin will diminish significantly. Hence, this stage is the last opportunity for the store to sell the remaining inventories with a relatively high margin. Stage 2 is characterized by a <80-60% freshness level of produce, which means 60% to 80% of the produce is still fresh and edible. In this stage, edge computing continues to analyse the real-time IoT-sensor data to determine the freshness level. If the freshness level is lower than 80%, the selling price (p_2) is set automatically, and this info is distributed in the whole store information system seen in *Section I*.

Stage 3 - Redistribution Stage: Stage 3 refers to the end of the selling season of fresh produce in the grocery store due to the lack of required quality standards. It is assumed that the grocery store can sell a high-quality level of produce with the above 60% of the freshness level. From this point, the leftover is required to be redistributed to another low-cost or discount store by incurring an additional cost, namely redistribution cost, c_R. It is assumed that the unit price in this stage, p_3, is relatively lower than in previous stages, $c_0 \leq p_3 < p_2 < p_1$, since $p_3 = p_2 - c_R$. Stage 3 is characterized by <60-20% freshness level of produce, which means that 20% to 60% of the produce along the selling period of time for (t_3) is still edible, but its quality is not enough to be sold out at the grocery store. At this stage, in order to prevent food waste, unsold produce will be distributed to the discount markets within the retailing concern, and the monitoring process continues there. The freshness level of produce is still monitored by the sensors to trace compliance with the determined quality standards. The real-time IoT-sensor data is aggregated in the grocery store and analysed by edge computing to determine the freshness level and set the discount price, p_3. This information is also distributed to all discount store information systems seen in *Section III*.

Stage 4 - Disposal Stage: Finally, the remaining inventory is disposed of at Stage 4. The discount store incurs a unit disposal cost, $c_D (c_0 < c_D)$, if the disposal is necessary. Thus, any leftover at the disposal stage will be sold with a negative profit, and the grocery will generate a net loss from this produce. The disposal stage refers that the freshness level of produce is typically less than 20%. The remaining inventory of produce is not suitable for human consumption, and this should be disposed of immediately due to the low level of freshness. The remaining inventory can be sold to food waste producers during the period (t_4) to turn food into nutrient-rich animal feed and organic fertilizer, rather than disposing of food waste through landfills or incineration. x_0 represents the on-hand inventory at the beginning of the sales period, while x_1, x_2, and x_3 are the leftover inventories after each stage.

NUMERICAL EXAMPLE

This section provides numerical examples obtained from simulation runs for the proposed IoT-freshness sensor data-driven price information system in the grocery retail stores. The simulation model of this study is written in the Python programming language. In order to simulate the operations of a grocery supply chain that implements hyperspectral imaging sensors in its operations in a pilot project for bulk apple sales, the real-time IoT-freshness sensor data is generated and this data is used in the simulation. In this section, the goal is to analyse the effect of the sales price (p_i), initial replenishment amount (x_0) and discount rate (d_i) on profit and food waste. Each simulation run reflects a 30-days of grocery store sales scenario in which the customer arrivals, each customer's demand, and price

expectations are assumed to be normally distributed. The distribution parameters are given in Table 1.

Simulation Event	Distribution Parameters
Customer Arrivals	N ~ (20,3)
Each Individual's Demand	N ~ (5,1)
Customer Price Expectation	N ~ (120,25)
Quality Decay Rate (%)	Real-time hyperspectral imaging sensors data

Table 1: Simulation event parameters

The simulation is run to analyse the effects of sales price, the initial purchase amount, and the discount rate on food waste. The analysis shows that these parameters have significant effects on the food waste of the grocery store.

Effect of the sale price on food waste

Figure 2 depicts the effect of the sales price of the produce on the food wasted at the end of the sales season. Based on the simulation results, the food waste is minimized (zero food waste) when the sales price is set within a range. Under the threshold price shown in the figure, the grocery store sells the whole quantity that results in zero food waste. When the sales price exceeds the threshold value, food waste occurs, and it increases as the sales price goes up. As the grocery store increases the sales price, the wasted food quantity increases as well. Hence, the grocery should set the sales price to the point where the food waste is zero and profit is maximized. This is shown in Figure 2.

Effect of replenishment amount on food waste

Figure 3 illustrates the effect of the initially purchased quantity on the food wasted at the end of the sales period. The red-dotted line shows the threshold value for the initially purchased quantity where the profit is maximum. Any quantity after this threshold will reduce the profit due to the food waste that occurred. The grocery store should purchase the threshold quantity to generate zero food waste and maximize its profit.

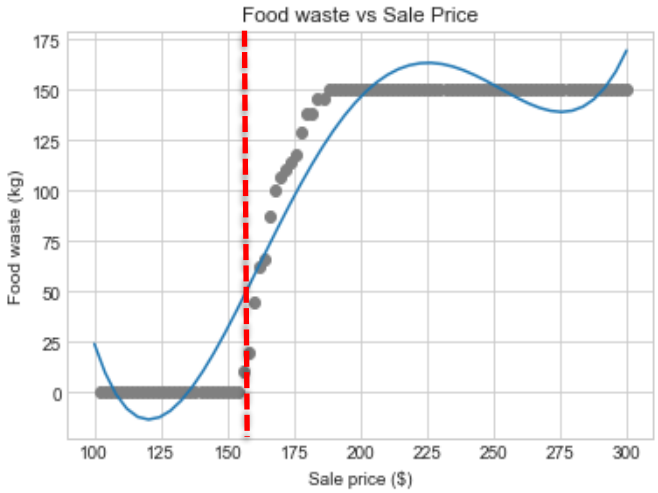

Figure 3: Effect of the sale price on food waste and profit

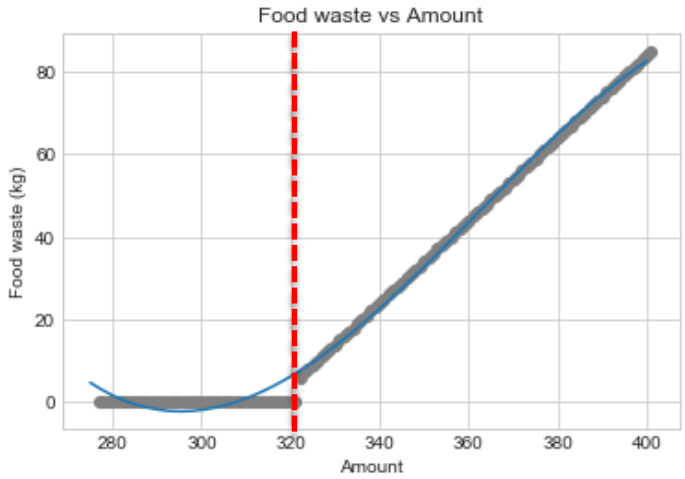

Figure 4: Effect of initially purchased quantity on the food waste

Effect of discount rate on food waste

The consumers' purchasing decisions can be manipulated by the discount strategy of the grocery store between stages. As the produce loses its freshness, the discount strategy will help the grocery store deplete the remaining inventory. Figure 4 depicts the effect of the discount rate between stages on the food waste at the end of the sales season. In this example, a 10% discount rate generates zero food waste while maximizing the overall profit. Therefore, the grocery store should decide on a discount rate that minimizes food waste while maximizing its profit.

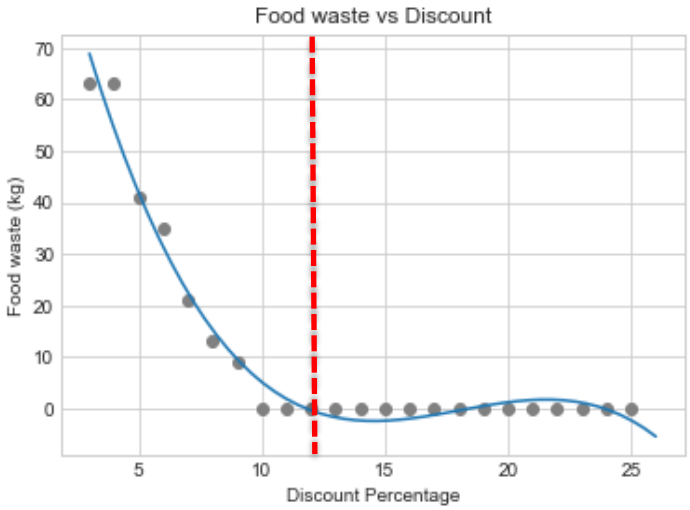

Figure 5: Effect of discount rate on the food waste

The effect of freshness score on profit and inventory level

Figure 5 illustrates the profit and the remaining inventory based on the freshness stage during the sales period (t). In the simulation run, the grocery sells the entire stock and maximizes its profit at the end of the second stage. Hence, the grocery should set a sale price for the grocery item to maximize the profit while selling the entire inventory before the beginning of the third stage.

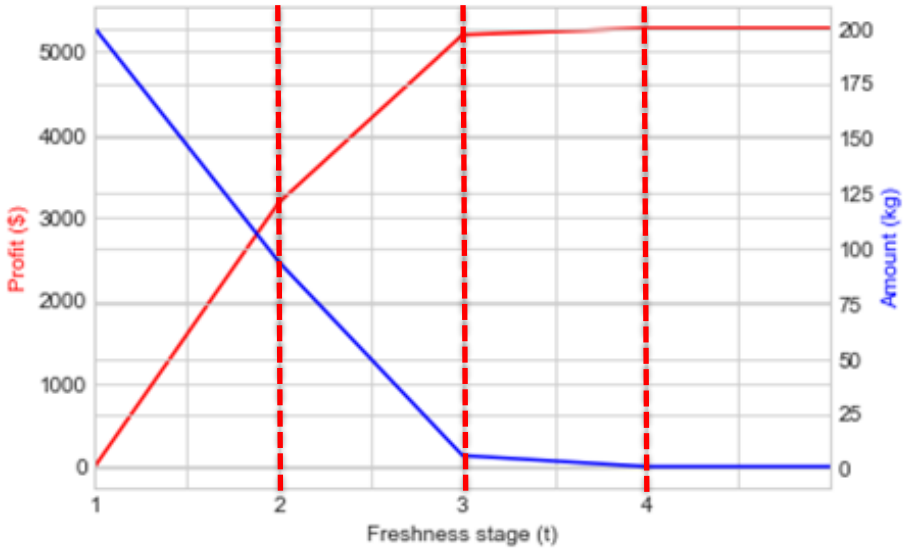

Figure 5: Profit and remaining quantity based on the freshness stage

CONCLUSION

This study proposed an IoT-freshness sensor data-driven price information system for bulk fresh produce with a four-stage pricing strategy to reduce food waste. This proposed price information system is useful for grocery supply chains to control and limit food waste. Also, this system can help prevent and reduce food waste that may occur due to disrupted food supply chains during the COVID-19 outbreak. The emerging technologies will continue to create new opportunities to extract value from food waste. The proposed system can be developed further with the integration of mobile applications. Not only IoT-sensors but also integrated mobile applications can allow customers to purchase discounted fresh food. A

good example of this extension would be a recent mobile application named "Too Good to Go" of HENA in the Netherland which offers users to purchase a "magic box"' with full of discounted food to reduce food waste at the grocery and discount stores. Conducting a Monte-Carlo simulation is the limitation of this paper. Future research can employ discrete-event simulation for the dynamic price changes within a day to further increase profit and reduce both waste and customer rejection rate.
This proposed system focused on food waste reduction only for bulk food products. In the future, this pricing system will be extended by including packaged food with lot-sizing constraints. Transforming selling strategy from the bulk to packaged food products with small lot-size might reduce food waste better and lead consumers to purchase only what and how much they need.

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SECTION 2 – TRANSPORTATION, DISTRIBUTION & HUMANITARIAN LOGISTICS

Air cargo industry after covid-19: A research framework

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ABSTRACT

PURPOSE
The air cargo industry has benefited greatly from the globalization process in the past thirty years, experiencing robust growth. However, the recent Covid-19 pandemic has stagnated the industry, casting much doubt on its future. Will it be brought down by the deep recession of the passenger industry? What paradigm shifts can one expect from the industry? This study is thus initiated to explore the status of the industry and proposes a research framework for an in-depth investigation of a possible re-think in airfreight operations.

DESIGN/METHODOLOGY/APPROACH
We apply both a desk scan and a preliminary interview study of several Turkish air cargo customers before the pandemic to understand the status of the industry. As the pandemic is still unfolding and evolving, updated industry-wise statistics are used to derive our propositions.

FINDINGS
We posit the pandemic to be a catalyst for an industry paradigm shift, which will transform cargo movements from one that is largely dependent on the capacity of the passenger airlines to a network closely integrating both cargo and passenger flights. Dynamic pricing for cargo capacity will also be used more to charge customers based on their utilities. In response, freight forwarders then have to extend their industry and regional coverage for resilience and cost-advantage.

VALUE
This study sheds light on the effect of Covid-19 on the air cargo industry, providing a new example on how an external "grey swan" event has transformed a fast-growing industry unexpectedly.

RESEARCH LIMITATIONS/IMPLICATIONS (IF APPLICABLE)
The research propositions would need empirical validation and field data input to enhance the understanding on the possible paradigm shift in the industry.

PRACTICAL IMPLICATIONS (IF APPLICABLE)
The predicted paradigm shift, if verified, would significantly alter the industry landscape, presenting both challenges and opportunities for the players in the industry during and after the pandemic, much more than what a normal economic recession would.

KEYWORDS: Air cargo, aviation, Covid-19, competition strategy, transformation, innovation

INTRODUCTION

Rapid globalization and industrialization in the past thirty years since the end of the "cold war" and the opening of China's economy, as well as other emerging countries such as India and Brazil, have brought about stellar growth in world trade and economic prosperity for many industrializing countries. Scholars are proclaiming that "the world is flat" (Friedman, 2005), and many Multinational Corporations (MNCs) are operating a complex web of supply chains at a global scale where components and final products often move around by airfreight for a faster response to market (Fung et al., 2008). For high-value products such as smartphones and pharmaceuticals, the benefits of air cargo on the aspects of timeliness, reliability, and flexibility have largely outweighed the cost (and carbon) disadvantage, and air freight has become a popular transport choice in the logistics service industry. Indeed, the air cargo industry has grown in tandem with globalization for the past few decades and was predicted by Boeing to grow 4.2% annually until 2037 with traffic volume doubling by then (Boeing Company, 2018). This growth is highly correlated with the growing world trade and global networks of many MNCs (Feng et al., 2015). Despite being the most expensive transportation mode, air transport is also the fastest means of delivery and is often the default choice for time-critical, high-value or perishable long-haul freight. The rapid growth of air passenger traffic in the past few decades, which witnessed more than a four-fold increase from 1990 to 2019 (from 1.0 billion to 4.5 billion), has further lowered airfreight costs and provided much cost advantage to the full-service airlines in leveraging the passenger airplane belly capacity for freight. According to the International Air Transport Association (IATA), air cargo moves over USD$6 trillion worth of goods a year, accounting for 35% of world trade by value (IATA, 2020a).

However, being a beneficiary of globalization, the air cargo industry is also very sensitive to the headwinds in world trade. It had started to experience a first decline of the last decade in 2019 when cargo volumes decreased by 3.3% y-o-y due to the onset of the Sino-US trade war in 2018 (IATA, 2020b). Though the industry was expecting a rebound after a truce in the trade war in January 2020 with a US-China Phase 1 deal, the onset of an unexpected Covid-19 pandemic has posed a greater global challenge to the industry. The year 2020 has witnessed the largest y-o-y decline as air cargo volume decreased by 10.6%, an unprecedented decrease for the past 40 years (IATA, 2021).

The Covid-19 pandemic, first reported in Wuhan, China in late 2019 and declared by the World Health Organisation (WHO) as a pandemic on March 11, 2020, has since spread to more than 200 countries with over 107 million confirmed cases and 2.3 million deaths (Worldometer 2021, updated February 9, 2021). It has permanently altered business models and society around the world with prolonged lockdowns and various social restrictions implemented in most coronavirus-affected countries. Even after the start of mass-market vaccination in some developed countries from early 2021, the imbalance of the vaccinations administered across the world and the threat of various new variants of the coronavirus still present serious challenges to the ongoing fragile recovery. Thus the social and economic effects of the pandemic are likely to persist in this "new normal" for society and commerce globally (Roggeveen and Sethuraman, 2020).

This study therefore seeks to understand the effects of Covid-19 on the air cargo industry from a long-term perspective. As the industry is expected to begin recovery with the mass-market vaccination underway, we are more interested in examining the long-term effects of the pandemic on the industry. Will the recovery be just a perturbation or will the pandemic alter the industry structurally? With the passenger airline industry reportedly being the sector most affected by the pandemic (Haydor and Kumar, 2020), and the recovery to the pre-pandemic level not expected to take place before 2024 (IATA, 2020c), how will the gameplay pan out in the sister air cargo industry? What structural changes, operations and strategy-wise, are expected for the industry?

BACKGROUND OF AIR CARGO INDUSTRY

Air cargo transport involves the services from an origin(s) to a destination(s) needed to move cargo through a shipper, a forwarder, a ground transporter, an airline or carrier, and a consignee (Derigs et al., 2009). The shipper initiates the transportation with the forwarder acting as the intermediary between the shipper and the airlines. The ground transporter provides the road transport before and after the air transport, while the airline manages the cargo receiving, storage, tracking, loading, unloading, and finally, the shipment reaches the consignee.

Airlines, being a key player in the industry, comprises two types: the integrated express carriers such as DHL, and the passenger and cargo combination airlines, called full-service airlines hereafter. The former normally sells capacity to the shippers directly and offers price- and zone-tiered door-to-door services with its integrated ground transporter to manage the ground operation, and the latter is a conventional scheduled airline seeking to benefit from the available belly space of passenger aircraft as well as the dedicated freighters (Li et al., 2012). The freight forwarders serve as the bridge between the non-integrated carriers and shippers while the integrated carriers may also sell their capacity to these forwarders, subject to availability. Similar to the general logistics services industry, the main service providers in the air cargo industry comprise a few large asset-intensive carriers (either integrated such as DHL or non-integrated such as Turkish Cargo) and a highly fragmented pool of numerous smaller albeit asset-light freight forwarders.

Adopting the well-known Porter's five-forces framework (Porter, 1980), we first examine the competitive landscape of the industry. On the horizontal dimension (substitutability and entrant barrier), the industry, in general, is very difficult to be substituted since air-shipment is the best means for reliable long-haul cargo delivery within a relatively short time window. As for the threat of entrants, the carriers and forwarders are situated in very different positions. For the carriers, there is only a very limited number of airlines in the world with international connectivity, and the high asset-intensity and the heavy regulations over the airlines curtail the easy entry of new entrants into this industry. Conversely, the relatively asset-light nature and much lower asset cost of the freight forwarders readily draws in new entrants. The forwarders thus have to strive within and without the national borders to sustain a competitive advantage in the market through high-quality customer service at a relatively reasonable cost.

On the vertical dimension, supplier power is low for most products due to the efficient market competition. There are a few exceptions for some critical supplies such as airplanes due to the high technological complexity and an oligopolistic market. The power of the buyers, in general, is not strong either as the unit air cargo cost is a small percentage in comparison to the cargo value and the value of time. Air cargo services, therefore, enjoy relatively high profit-margins amongst the family of logistics services. Given the rapid market growth and high-profit margins, the intensity of competition among the existing players is low compared to the other sectors in the logistics industry.

Through an empirical study on a large full-service airline, Feng et al. (2015) has shed much insight into the industry from the perspective of the airlines. While full-service airlines operate both passenger and cargo flights, their cargo capacities are largely constrained by the belly capacity of the aircraft, which are regarded as "costless" (p. 276). Such a mind-set brings out the practice of selling ahead much of the long-term capacities of the airlines to the forwarders based on relationships, which was verified in our case study later in this paper as well. While some cargo capacities are sold with dynamic pricing like the passenger airlines (an example is UPS), the majority of them are contracted to the freight forwarders on a long-term basis (typically set as a framework agreement), with a price discount in advance and no penalty for unused space. Airlines often fret over the capacity imbalance when some heavily demanded routes experience severe over-ordering despite the high freight rates while many underutilized ones are heavily under-booked even in high seasons (Fung et al., 2015: 276). The freight forwarders would then complain about the capacity

shortage rather than the pricing as they can easily pass the cost to their clients if forwarders can manage to book the capacity. Different from passenger flows, many cargo demands are uni-directional with no or fewer goods on the return leg. Such characteristics, similar to ocean freight, further limit the ability of the airlines to open additional cargo flights for the routes in high demand, in addition to the constraints imposed by the Freedoms of the Air Agreements honoured by the airlines.

In sum, we note two observations about the industry before Covid-19. First, the industry is largely operated as a subsidiary of passenger airlines which largely determine the flight route and capacity. The cargo department of full-service airlines is largely viewed as a subjugated sector whose capacity is exogenous. Second, the "costless" nature of the capacity means that airlines tend to be reactive rather than proactive when selling their belly capacities, leaving the majority to the management of forwarders. Such a pricing scenario is very different from passenger airline ticketing where dynamic pricing is used frequently in ticketing and the profitability of the third parties is optimally reduced to a minimum (McAfee and Verde, 2006).

PRELIMINARY STUDY ON AIR CARGO FORWARDERS

In addition to the literature review, we elected to call on a small-scale semi-structured interview as a preliminary study on the air cargo forwarders. The study began in November 2019 before the onset of Covid-19. We had then initiated a case study of a French-based IATA certified forwarder in Turkey, labelled as Firm A, for reasons of confidentiality. At that time, four key customers of Firm A were interviewed to glean insights into the industry and to solicit first-hand information about the problems faced by the firms. The study provided a good insider-view over the status of the industry before the pandemic.

Firm A was established in the late 1980s, and started to operate in Istanbul, Turkey in 2015. In 2019, it made its entry into Izmir, the third-largest city of Turkey and the gateway to the Aegean region, the manufacturing hub of the country. Firm A specializes in the transportation of aerospace, automotive, and spare parts with airfreight, sea freight, project logistics, and other value-adding services. The focus of Firm A is on international shipments through an integrated global network for door-to-door deliveries. In less than a year, Firm A has managed to attract various customers from multiple industries in the new market.

To support the case study, Firm A shared the contacts of four of its customers in Izmir, denoted as Companies B, C, D, and E in this paper. Most of them are shippers, but one is a freight forwarder as well, and their background information is shown in Table 1. Information is mainly drawn from the semi-structured interviews to elicit first-hand data from the logistics personnel of the four firms. Each interview, conducted in Turkish, lasted 30 minutes. Table 1 contains the summary of interview results.

Table 1: Interview Result & Summary of Case Study on Firm A

Company	Goods Airfreighted	% of Business to Firm A	% of Business of	Reasons for choosing Firm A
B	General cargo (plastics)	100%	3%	personal contacts /payment terms
C	Special cargo (perishables)	100%	2%	personal contacts / operation
D	Freight forwarder but not IATA certified	20%	5%	freight cost
E	Special cargo (flammable explosives)	20%	3%	operation knowledge

Table 1 shows that the key motivation for these companies to work with Firm A is "personal contacts" as three of the four companies mentioned this factor, followed by "operation knowledge" with two mentions, both from the customers with special cargo (C and E).

Company E highlighted that they chose Firm A recently because the other logistics firms were not willing to render much help in shipping their special cargo, dangerous goods. The other factors, "payment terms" and "freight cost", scored one mention each. From the interviews, we realized that air cargo cost is normally not the critical factor as the value of goods in the shipment is typically much higher. The shippers are more concerned about the timeliness and responsiveness of the forwarders, and therefore personal relationship provides the assurance of responsiveness in a country such as Turkey, which bears an Oriental practice of guanxi or relationships. For Company D which is a forwarder itself but has no IATA certificate to ship air cargo directly, it has to outsource the cargo shipment to Firm A. Company D is rightly more concerned about cost as its profit margin is directly affected by the air cargo cost set by Firm A.

An additional interview with Firm A showed it was building competitive advantage mainly through service integration across multiple transportation modes and markets. It manages sea and ground transportation as well as air and covers multiple European markets to provide door-to-door services for its customers. Service quality rather than cost is the focus of the firm. The interview also reveals that some freight forwarders are not active in keeping small or special customers like Company C and E, which leads them to choose the new entrant (Firm A) for better service instead. This response is understandable as a good relationship with the airlines would secure them sufficient business in a sector dominated by sellers or suppliers as noted in the last section, and the main complaint of the airfreight forwarders is often directed at the capacity constraint rather than the cost.

In summary, before the Covid-19 pandemic, as airlines tend to allocate cargo capacity based on relationships rather than price, the priority of the airfreight forwarders is to maintain close relationships with the airlines to secure sufficient cargo slots on routes with heavy demand, followed by high-quality services such as transport mode integration to attract customers. The cost factor is relatively lower in the priority order as both the airlines and shippers are largely not concerned with the cost. In contrast, the dynamic pricing in passenger flight ticketing has successfully differentiated the demands of travellers to generate more revenue (and profitability) for the airlines where the last-minute travellers were charged more due to the exigencies of travel (McAfee and Verde, 2006; Siegert and Ulbricht, 2020). Likewise, it is plausible for two types of customers to co-exist in the cargo market as well. A firm may book cargo flights way ahead, based on factory production schedules while the other type of customer chooses airfreight for emergency production needs just one or two weeks ahead. The current market practice leaves most of such profit to the freight forwarders who have pre-booked capacities from the airlines much earlier with lower risk as they can return the unused capacity to airlines without penalty, other than the reputation loss and a small reduction on future cargo space bookings.

AIR CARGO INDUSTRY DURING COVID-19

However, the Covid-19 pandemic has significantly changed the landscape of the air cargo industry. Since March 2020, when most of the developed economies experienced severe travel restrictions and unprecedented travel disruptions, the global air cargo demand has declined severely. From IATA's monthly market reports, in the first six months of 2020, air cargo demand decreased by 14.5%. While the market demand started to rebound in the second half of 2020, as informed by the Purchasing Managers Index (PMI) exceeding 50 since Sept 2020, the growth in air cargo has been stalled by capacity constraints. The belly capacity of the airlines has declined 53% for the whole of 2020 due to the collapse of international travel, resulting in an annual cargo capacity decline of 23% (IATA, 2021).

As the recovery of the international travel market is still far away, the full effect of the cargo capacity constraint is expected to continue for several more years. While airlines have increased the freighter's fleet size and the daily utilization of aircraft, we would expect some possible paradigm shifts with this extended pandemic.

Applying Porter's five-forces framework to examine the industry landscape (Porter, 1980), we may easily notice that substitutability and supplier would largely be unaffected by the pandemic, and the threat of external entrants has even been dampened by it. Thus, demand and industry competition would be two critical aspects for consideration.

Demand Analysis during the Pandemic

As the customers of the air cargo industry are well dispersed across many sectors, we would expect that demand for air freight should largely follow the general economic trend. After the sharp economic decline in early 2020, one would expect to witness a slow and uneven recovery from 2021, indicating a slow recovery of the air cargo demand. Specifically, there may exist two factors affecting air cargo demand during the pandemic. First, a somewhat positive externality, as the spread of the virus and the scale of the economic lockdown vary along with the unfolding and severity of the pandemic, the frequency of supply chain disruptions may increase, resulting in a greater need for emergency orders to be expedited by air. Manufacturers may therefore employ more airfreight instead to ship some critical parts, which have been delayed due to pandemic related disruptions, from the other parts of the world (Wagner, 2020). Second, a negative externality, one impact of the pandemic is de-globalization, where global supply chain operation is moving towards less globalized, less complex, and more resilient to reduce the chain's sensitivity to disruptions of a black swan nature (Gereffi, 2020). The need for airfreight may decrease along with the localization of many industries, either by choice or design. Combining the two factors, leads to following proposition:

Proposition 1: *Air cargo demand during and after the pandemic would largely follow the general economic activities without much deviation from the pre-Covid period.*

Industry Paradigm Shift during the Pandemic

The Covid-19 pandemic will intensify industry competition for both the full-service airlines and airfreight forwarders, and this may start to create an industry paradigm shift. For the airlines, besides the operational adjustments made during the pandemic, the strategic shift would be more challenging. Financial wise, we have already seen deep financial losses and corresponding more government bailouts (Abate et al., 2020). As such, one would expect a prolonged period of consolidation, further evidenced by bankruptcies among the regional airlines, and even the mergers and acquisitions of the larger global airlines. Moreover, we could expect a paradigm shift based on the following discussion.

As shown in the recent review of the industry by IATA (2021), the main concern of the industry is the capacity crunch due to fewer passenger flights, which have shrunk by 53% in 2020, leading to a corresponding decline in belly capacity for air freight. Such a scenario may actually benefit the integrated carriers as the latter would enjoy higher profitability due to the supply scarcity. They may also stand to gain from the pandemic with their cargo fleet and integrated multi-modal networks. On the other hand, the full-service airlines are experiencing a much more difficult time. It is reported that the number of flights remained more than 40% below the pre-crisis level globally and the decrease in long-haul flights is more severe (OCED, 2020). Such a decline would severely limit the cargo capacity of the full-service airlines, hampering the capability of freight forwarders such as Kuehne + Nagel who engage in long-haul air freight transport. Therefore, such marketplace realities may renew the call for an innovative response to such a problem.

Observing a clear discrepancy between air cargo demand (decrease of around 12-15%) and the supply of passenger flights (40%-50% decline) in late 2020, it is expected that cargo capacity will decline by about 30% globally. As the recovery of the international passenger flights is expected to be very slow with a full return no earlier than 2024 (IATA, 2020c), the community of cargo carrying airlines need a paradigm shift to address the issue, not allowing potential business opportunities and revenue to slip away. We thus expect two possible strategic changes in the industry, presenting in Propositions 2 and 3 below.

Proposition 2: *There would be more integration between cargo and passenger flight planning to increase cargo capacity for full-service airlines during the pandemic.*

Proposition 3: *There would be more dynamic pricing for the cargo capacities of the full-service airlines during the pandemic.*

Regarding Proposition 2, the integration of cargo and passenger flights is possible, due to two factors. First, it is the sharp decline of passenger demand, particularly the international flights, with little hope of a quick recovery. The second is the uni-directionality of cargo demand, making a pure two-way cargo flight unprofitable. Since the long-haul travellers during the pandemic are less likely to return anytime soon due to the costly and cumbersome health and quarantine requirements or even risking potential lockdowns, passenger flows are less symmetric with fewer tourists or business travellers but more people for study, work, and family. Integrating the planning of passenger and cargo flights would make more routes profitable. During the early stage of the pandemic, many airlines had actually activated the idea of integration when evacuating their overseas citizens from pandemic-hit countries. The planes often carried urgent medical-related cargoes such as personal protective equipment (PPE) before taking back their citizens. We would only expect such a practice to become more frequent and wider spread. Certainly, such integration requires much re-configuration and support from the stakeholders. For example, airlines may need to choose a type of aircraft amenable to quick conversion of the seats on the upper deck, and send a team of technicians to the targeted airport to implement the plane modification. The airport can also facilitate the transformation by enabling some passenger terminals with cargo loading capabilities to reduce the aircraft turnover time on the tarmac of the airport. As many airports have experienced demand shrinkages with empty terminals, such a transformation may generate additional revenue for them too. In addition, the integration may improve the efficiency of aircraft usage, reduce the carbon emission, and benefit the environmental protection as well.

On Proposition 3, the full-service airlines can no longer view cargo capacity as "costless" in this pandemic among the deep economic distress. There is an imperative to manage such capacity proactively with more sophisticated tools and generate greater revenue out of the capacity asset. Just like managing the passenger tickets with dynamic pricing for higher profitability, the airlines could manage their cargo capacities similarly and integrate the pricing of both passenger and cargo flights. For example, instead of rewarding two-way passenger flights naively, the airlines should reward passengers to fly one-way along the route with less cargo demand to address the imbalance along some of the popular cargo routes. As noted by Feng et al. (2015), with a huge amount of data available for the airlines, a data-driven decision-making tool on cargo pricing could become a revenue-generating solution for the airlines in the downturn caused by the pandemic. Just like securing cheaper flight prices when booking tickets early but with high cancellation charges in the passenger market, the airlines should no longer allocate their cargo capacities to the airfreight forwarders without any cancellation penalty. Rather, they should impose high cancellation or "no-show" charges to motivate the forwarders to proactively manage capacity to secure joint profitability. The pricing of the same cargo route may increase nearer the scheduled departure date, similar to the passenger flight tickets currently (Siegert and Ulbricht, 2020). In short, there is need to provide yield management. Firms that book emergency cargoes would then be charged more for the higher utility of the airfreight. The airlines could then take advantage of the relatively high demand for emergency airfreight during the pandemic to generate more profit through better pricing models.

For the freight forwarders, if a dynamic capacity pricing model is implemented by more airlines, then the forwarders would have to change their business models as well. The airfreight forwarders can no longer solely rely on their informal relationships with the airlines established during the pre-Covid times. In the post-Covid era, with keener price competition, they have to develop sophisticated pricing models and strategies as well, in

addition to maintaining good customer management and high-quality services. This was what happened not too long ago in the case of the air passenger market. The airlines then started to sell their flight tickets directly through the Internet rather than relying on travel agencies. As a result, many of the brick and mortar travel brokers struggled or even went bankrupt such as the century-old Thomas Cook Group (Collinson, 2019). However, the asset-light new-generation booking agencies such as Booking Holding and Expedia Group could still thrive in the highly competitive market by leveraging across multiple airlines and sectors (Team, 2019). In the cargo market, the airfreight forwarders need to execute a similar approach by developing more predictive analytics-based and sophisticated business models to offer comprehensive and competitive solutions to their customers by leveraging across airlines and geographies. They have to transform from embracing a mentality of "getting it done" to a more nimble mentality of "doing it more efficiently in competition". For example, the airfreight forwarders can extend their industry coverage by developing broader skill sets and customer bases to make them more resilient to demand shocks from specific client industries. As the impact of Covid-19 is unevenly felt (Haydor and Kumar, 2020), a broad industry base may stabilize a firm's cash flow and help its survival. Moreover, as many air cargoes may complement each other, shipping them in a consolidated manner can actually reduce the shipping cost and increase firm profitability. For example, textile products are often light but occupy much space; their shipping cost is charged by volume rather than by weight. If they are combined with heavy but small-size spare parts in the automobile industry whose shipping charge is normally by weight, then the overall shipping cost of both items may reduce significantly. Such an approach may also reduce the carbon emission of aviation activities and contribute to the sustainability of the industry. Thus, we present the next proposition.

Proposition 4: *In response to more dynamic pricing for cargo capacities by the full-service airlines, the airfreight forwarders would have a broader industry and region coverage and integrate multi-modal services to generate resilience and cost-advantage in the post-pandemic age.*

CONCLUSION

From an industry predicted to have a bright future, the air cargo sector has gone through a turbulent time with the Covid-19 pandemic. Through an industry analysis, four propositions are proposed for further empirical verification. We expect no significant qualitative changes on the demand side, while an industry paradigm shift is expected to occur for both the full-service airlines and airfreight forwarders. The airlines are expected to integrate more of their passenger and cargo flights and improve the pricing of cargo capacity based on a workable dynamic pricing rubric. Similarly, the airfreight forwarders may experience greater difficulty operating in such a context and have to extend their customer bases to cover multiple industries and regions, which may provide resilience against specific industry shocks and complementary benefits such as cost reduction.

A severe economic downturn caused by "grey swan" events such as Covid-19 would certainly bring about a period of consolidation for the industry. Moreover, the cargo capacity crunch due to the demand discrepancy between cargo and passenger demands may induce an industry re-alignment, which may transform air cargo flights from one largely constrained by passenger airlines' belly capacity to a network closely integrating both cargo and passenger flights with many needed changes in the airlines and ground-side operations as well. Such a transformation would shift the industry landscape significantly with both challenges and opportunities for the stakeholders during the pandemic, much more than what a normal recession would. Our exploratory study on the key players in Turkey points in this direction, though a more rigorous empirical investigation is needed to verify what we have proposed so far.

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HUMANITARIAN LOGISTICS: A SYSTEMATIC LITERATURE REVIEW

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Purpose of this paper:
This study aims to conduct a systematic literature review to understand the research trend, identify areas needing further improvements and propose future study in the humanitarian logistics area.

Design/methodology/approach:
Using Netminer 4.0, bibliometric analysis, keyword frequency analysis, keyword network analysis and topic modelling analysis were conducted.

Findings:
As a result, it was discovered that after the middle of 2010s, the amount of studies related to HL(Humanitarian Logistics) surged. Also, it was revealed that the main issues in HL were changing continuously. Keyword frequency analysis and keyword network analysis show that from 2005 to 2009, establishing the identity of HL and disaster response, recover and preparation were the main issues in that period. It was discovered that transportation and education from 2010 to 2014, and coordination and provision from 2015 to 2019 were mainly studied in HL. After topic modelling analysis, nine topics (coordination, preparation, sustainable development, stakeholders, recovery, facilities location, emergent response, transportation, supplying and sourcing) were extracted. Among them "facilities location" was on the 1st rank and "preparation, recovery, emergent response, stakeholders" were cold topics and "coordination, facilities location, supplying and sourcing" were hot topics.

Value:
There were no previous literature review using network analysis and topic modelling in HL so far. Thus, this study can suggest objective and quantitative literature review using a new method and will be helpful to provide the future research direction in HL.

INTRODUCTION

As the world is currently suffering from the COVID-19 pandemic, it makes sense that humanitarian logistics(HL) is rising as a field that needs, more than others, to be developed more urgently. Van Wassenhove (2006) stated that "HL is changing… as logistics started to be recognized as integral to any relief operation"(p.475).The importance of HL is emphasized in a 2017 Report by Action contre la Faim(Action Against Hunger), which mentions that "the organization's supply chain and logistics costs range between 62% and 79% of all costs(p.6)", and that "therefore, the focus of humanitarian investments should at least give further consideration to build capacities in this field" (p.9). Research on HL has been conducted actively, as seen in the launch in 2011 of the *Journal of Humanitarian Logistics and Supply Chain Management*, and an increasing number of articles on HL in various journals (Jabbour et al., 2017). There have been many attempts to analyze current research trends and set future research directions, including the analysis of research trends from 2005 to the early 2010s—a period during which research on HL started to fully embrace the traditional literature review methodology, which focuses on introducing HL and pointing out its importance. Later, as studies were more actively conducted, they mainly adopted the bibliometric methodology, which can analyze and forecast major research trends by determining which researchers are most influential and clustering them based on related statistics (e.g., number of articles and citations); clustering can also uncover affiliations among authors.

However, there is scarcely any research trend analysis that uses network science, which leverages network modeling to analyze phenomena that exist in society or nature. Although

network analysis is actively used in other fields of study, there has been virtually none in HL. One exception is Zary et al.(2014), who undertook research trend analysis with respect to citations and co-citations to present knowledge networks. However, analytical limitations exist when citation relationships are analyzed by undertaking research trend analysis of the literature (Kho et al., 2013). Meanwhile, other studies use social network analysis (SNA), a type of network analysis to explore social networks related to HL; they do so by analyzing cooperation among relief organizations and patterns of community structures, the characteristics of online user networks in disasters, and communication patterns among organizations involved in HL in Latin America (Tacheva and Simpson, 2019; Kim and Hastak, 2017; Álvarez et al., 2013). However, it is challenging to find studies that adopt network analysis, especially topic modeling and keyword network analysis in HL research anlaysis. Therefore, the current study looks to uncover HL research trends by using network analysis in an innovative manner. To the best of our knowledge, this attempt is the first of its kind in research trend analysis of HL.

The current study comprehensively shows research trends in HL by leveraging two methods of network analysis—namely, keyword network analysis and topic modeling. First of all, the current study determines the key issues in HL, using a keyword network analysis method that examines similarity by calculating the frequency of simultaneous appearance of keywords as well as trends vis-à-vis their time series. Moreover, using topic modeling analysis, that method determines the key research topics in the area of HL; it also examines changes that occur within the time series. The current study's adoption of this complex research trend analysis method makes it important, as it allows us to provide comprehensive and objective views on the research trends of HL and effectively set the direction for further research; additionally, it is a method not frequently found in trend analyses in the same field.

LITERATURE REVIEW ON HUMANITARIAN LOGISTICS

Many efforts have been made to date to summarize research trends in HL and set the future direction for research. Kovács et al. (2007) and Overstreet et al. (2011) provide the basic framework by which to understand HL, using qualitative research methods. Richey et al. (2009) classified and summarize research findings regarding supply chains in crises into five frameworks. Altay and Green (2006) summarize the literature on the OR and MS of HL; Galindo and Batta (2013) undertook research trend analysis on OR/MS in HL, to bridge the post-2006 research lacuna. Meanwhile, there have been research trend analyses on HL and which center on optimization models (Caunhye et al., 2011) and transportation models among the OR of HL (Safeer et al., 2014); there has also been a literature review on inventories (Whybark, 2007). Additionally, other analyses cover unique topics such as infectious diseases, biochemical terrorism, disasters in certain regions, refugees, and the transparency of HL (Khan et al., 2019). Most studies before 2013 adopt the traditional literature review methodology; these include attempts to use meta-analysis (Kunz & Reiner, 2012) and what was the most extensive literature review of the time (Leiras et al., 2014). On the other hand, after 2014, the methodology of choice was largely the systematic literature review (Zary et al., 2014; Jabbour et al., 2017). Systematic literature reviews can reduce the subjective bias of authors otherwise seen in traditional literature reviews (Jeong & Park, 2019); additionally, the number of related studies increased considerably, making it possible to apply the systematic literature review methodology (Jabbour et al., 2017).

NETWORK TEXT ANALYSIS

Network Text Analysis (NTA) is one method for encoding the relationships between words in a text and constructing a network of the linked words (Diesner & Carley 2004); it is based on the thinking that "texts can be represented as networks of concepts" and "the extracted networks contain representations of social structure"(Diesner & Carley, 2005, p.2). Network Analysis is evaluated as a new research methodology paradigm that can be used to uncover significant research findings not easily discovered using other existing methodologies (Lee, 2012) and using NTA, researchers can interpret previously unknown

relationships among concepts(Diesner & Carley, 2005). Among the methodologies inherent in NTA, network centrality analysis measures the influence of each node in the network (or keywords, if it is a keyword network); it attempts to find highly influential keywords and understand the intent and meaning delivered by the entire text (Park & Jeong, 2013). In centrality analysis, degree centrality is the key indicator that speaks to how many connections a certain word has with other words. The greater the number of direct connections a node has with neighboring nodes, the higher the degree centrality it has. Words with high degree centrality are those keywords that convey the research topic (Song et al., 2018). Betweenness centrality is a concept that measures just how much of a mediating role one node plays in building a network with other nodes; the node undertaking this role can have a great impact on controlling the information flow. Betweenness centrality is measured in terms of node proximity; concepts with high betweenness centrality create various meanings in the overall text (Park & Jeong, 2013) and are useful in finding connectivity between two different research topics (Jeong & Kim, 2018).

Topic modeling, another network analysis method, finds the topics latent in the text of existing materials, and it documents and analyzes the ways in which topics interconnect (Blei, 2012). Latent Dirichlet allocation (LDA) is the most commonly used topic modeling technique. With this technique, one extracts topics based on highly correlated words by calculating the frequency of simultaneous appearance of keywords in a massive document dataset (Blei, 2012). LDA topic modeling generally uses simple algorithms and is advantageous in reducing data volume and producing consistent topics. Mainly, it is frequently utilized in studies that look to pinpoint the topics in a large volume of documents (Yang et al., 2019). Furthermore, it is commonly used in research trend analysis, as with it, one can extract highly soluble topics from massive data; another of its benefits is that it makes it easier to capture research trends in a given field by examining time-series changes in the embedded topics.

RESEARCH DESIGN

The main purpose of this research is to identify the topics of HL studies and analyze the time sequential changes. To fulfill this goal, keywords analysis and topic modelling analysis were conducted using NetMiner 4.0 program. All the analyses illustrated in Table 1 were conducted by dividing into period in order to identify time series flow. We collected data from SCOPUS database using the keywords "Humanitarian & Logistics", "Humanitarian & Supply chains", "Disaster & Logistics", "Disaster & Supply chains", which were selected after examining a variety of keywords in previous reviews. The scope of the literature in this study is limited to articles and reviews published until 2019. We initially collected 4,269 papers. By examining the title and abstracts, we decided whether the papers have relevance to the topic. After filtering irrelevant papers and excluding the papers which were overlapped or without abstracts, we were left with 1,058 papers.

Steps	Details
Data Collecting	· Extracting relevant articles in Scopus database using keywords
Data Pre-processing	· Using NetMiner 4.0 program · Conducting process of screening papers · Making and applying exemption dictionary, designation dictionary, and synonym dictionary to the screened documents and extracting initial word dataset · Converting 1 mode network into 2 mode network using Inner Product · Filtering words in batch using TF-IDF value · Extracting final word dataset

Bibliometric analysis	· Number of published articles, top publishing journals and mentioned disasters
Keyword Frequency analysis	· TF(Term Frequency) and TF-IDF(Term Frequency- Inverse Document Frequency) analysis
Keyword Network Analysis	· Centrality Analysis (Degree Centrality and Betweenness Centrality Analysis)
Topic Modelling Analysis	· Extracting main topics in HL using LDA

Table 1: Analysis process

ANALYSIS RESULTS

Bibliometric analysis

The number of academic articles and review related to HL until 2019 was 1,058. The fact that the number of published articles in this area soared after 2009 as shown in Table 2 reconfirms the statements that "there were only a handful of articles on HL up till 2005" (Kovács et al., 2009, p.506) and "There was a sharp increase in the number of publications on HL, especially after 2009" (Leiras et al.,2014, p.103).

Year	No.	Year	No.	Year	No.	Year	No.
1986~2004	105	2008	9	2012	68	2016	120
2005	2	2009	40	2013	59	2017	105
2006	3	2010	27	2014	93	2018	158
2007	11	2011	49	2015	88	2019	213
Total	1058						

Table 2: No. of published papers by year

Table 3 shows top publishing journals contributing to HL. A special journal of HL, "*Journal of Humanitarian Logistics and Supply Chain Management*" took the first place publishing 11.6% of total papers. The top 8 journals published 345 of 1,058 papers, representing approximately 33.4% of all.

Journal	No.	Journal	No.
Journal of Humanitarian Logistics and Supply Chain Management	123	Socio-Economic Planning Sciences	29
Annals of Operations Research	52	Production and Operations Management	29
International Journal of Disaster Risk Reduction	35	Transportation Research Part E: Logistics and Transportation Review	28
European Journal of Operational Research	35	International Journal of Production Economics	23
Total		345	

Table 3: Top Journal contributing to HL

The frequency of disasters mentioned in papers are below. Natural disasters such as *earthquake, flood, hurricane, tsunami cyclone* were mainly stated, especially *earthquake* composing 47.5% of total. On the other hand, man-made disasters like *conflict, war, starvation* were mentioned marginally.

Disaster	No.	%	Disaster	No.	%	Disaster	No.	%	Disaster	No.	%
earthquake	279	47.5	conflict	24	4.1	typhoon	10	1.7	famine	4	0.7
flood	96	16.4	cyclone	19	3.2	rainy season	8	1.4	snow storm	3	0.5
hurricane	70	11.9	war	15	2.6	epidemic	8	1.4	starvation	1	0.2

tsunami	33	5.6	landslide	11	1.9	drought	6	1.0	Total	587	100

Table 4: Top Journals contributing to HL

Keyword Frequency Analysis

Keyword frequency analysis was conducted with 2,897 keywords of dataset applying TF analysis and TF-IDF analysis. We executed two frequency analysis dividing 15 years from 2005 to 2019 into period 1,2,3 each on a five-year basis. As period 1 is the initial stage, the trial to define the definition and confirm the necessity of HL appeared. These words such as *preparation, safety, disruption, rescue, united nation, private sector, vulnerability* show the trends. In period 2, interest in practical aspects of HL increased. TF value high-ranking words such as *shortage, supplier, procurement*, TF-IDF value high-ranking words like *emergency supplies, vehicle routing, equipment, delay* confirms these flows. The appearance of logistics optimization related words like *heuristic algorithm* and assessment of practicality of proposed plan related word like *feasibility* show these trends as well. Meanwhile, we could verify the concerns in man-power management through the words like *personnel, education*. In period 3, the parties concerned in HL and cooperation between them are assumed to be main topics. 7 out of 10 high-ranking words are related to co-operations and parties such as *community, coordination, government, supplier, collaboration, donation, partner*. Considering the fact that *route and road* are included in high TF value words and *sensitivity analysis* used for predicting business profitability or availability of funding are in TF-IDF high rank words group, we can infer that to arrange base for relief supplies was main issue at that time. In addition, the newly appearance of the word, *sustainability* means that interest in that area began.

	2005-2009(Period1)				2010-2014(Period2)				2015-2019(Period3)			
Rank	Word TF	no.	Word TF-IDF	no.	Word TF	no	Word TF-IDF	no	Word TF	no	Word TF-IDF	no
1	preparation	12	united nations	4	community	35	emergency supplies	13	community	67	reduction	25
2	coordination	11	restriction	4	coordination	25	vehicle routing	10	coordination	59	product	24
3	community	9	private sector	4	principle	21	property	10	government	52	donation	22
4	communication	7	performance measurement	4	communication	19	personnel	10	disruption	45	partner	21
5	safety	6	partnership	4	shortage	18	education	10	decision makers	45	trust	21
6	disruption	6	equipment	4	preparation	18	option	9	supplier	44	equity	20
7	rescue	5	vulnerability	3	supplier	17	heuristic algorithm	9	manager	42	arrival	20
8	performance measurement	5	treatment	3	humanitarian action	17	feasibility	9	route	41	sustainability	20
9	manager	5	staff	3	procurement	16	equipment	9	collaboration	40	sensitivity analysis	19
10	integrates	5	routing	3	trade off	15	delay	9	road	39	intervention	19

Table 5. Chronological TF, TF-IDF high ranking words(2005~2019)

Keyword Network Analysis

To find out key idea researched in priority in HL, network centrality analysis centering on degree centrality and betweenness centrality per period. Degree centrality is measured by

the total amount of direct links with the other nodes (Zhang & Luo, 2017). If a word high degree centrality, many concepts and variables are related with the word and many subjects of researches use the specific word (Moon, 2020; Song et al., 2018). High degree centrality words in each period such as *united nations, reconstruction, survivor* in period 1, *robustness, emergency supplies, delay* in period 2 and *trust, united nations* in period 3 show that the main concerns of each time such as stressing importance of HL, focusing on practical progress of HL, and cooperation respectively. Betweenness centrality is to measure one node undertaking 'mediation' role in a network. If one node locates in the only way which other nodes have to go through, then this should be important and very likely have a high betweenness centrality (Zhang & Luo, 2017). The words which have high betweenness centrality take lead of fusion and connection of researches and play an important role in creating various meanings in whole documents. We could confirm that study on severe damages of disasters were done through the words like *chaos, disturbance* and study on instant response through *authority, early warning system.* For period 2 when Sudanese civil war and Syrian civil war were proceeding, we can assume that the scope of research on relief activities was broaden through the words like *emergency supplies, disaster affected regions*. In period 3, it can be inferred that through the high betweenness centrality words like *provision, reduction, equity* and *feasibility,* the study on supplies of relief goods and required infrastructures were conducted actively. In addition, it is assumed that by the medium of the word *trust*, cooperation of HL was studied. Top words can be found in the Table 6.

Rank	2005-2009 (period1)	Degree Centrality	2010-2014 (period2)	Degree Centrality	2015-2019 (period3)	Degree Centrality	2005-2009 (peirod1)	Between-ness Centrality	2010-2014 (period2)	Between-ness Centrality	2015-2019 (period3)	Between-ness Centrality
1	united nations	0.26950	education	0.05333	provision	0.05333	equipment	0.19917	emergency supplies	0.06000	provision	0.09931
2	Re construction	0.26950	robustness	0.04000	trust	0.04296	authority	0.18364	delay	0.05849	feasibility	0.06433
3	survivor	0.25532	option	0.04000	reduction	0.03852	chaos	0.16859	disaster affected regions	0.05433	trust	0.06199
4	equipment	0.21986	emergency supplies	0.04000	agility	0.03852	early warning system	0.16713	press	0.04972	reduction	0.05994
5	treatment	0.19149	delay	0.04000	united nations	0.03704	disturbance	0.16481	option	0.04917	equity	0.05533

Table 6: Chronological degree centrality and betweenness centrality high ranking words (2005-2019)

Top keywords for degree centrality are *provision* followed by *united nations, partner, trust* and *donation* while top keywords for betweenness centrality are *united nations* followed by *provision, feasibility, trust* and *donation* over the entire period from 2005 and 2019. Top words in all periods can be found in the Table 7

Rank	2005-2019	Degree Centrality	2005-2019	Between-ness Centrality	Rank	2005-2019	Degree Centrality	2005-2019	Between-ness Centrality
1	provision	0.04634	united nations	0.05299	9	employee	0.03556	sensitivity analysis	0.03247
2	united nations	0.04526	provision	0.05176	10	vehicle routing	0.03448	product	0.03232
3	partner	0.04310	feasibility	0.04735	11	feasibility	0.03448	advantage	0.03180

4	trust	0.03987	trust	0.04061	12	equity	0.03448	staff	0.03170
5	donation	0.03987	donation	0.03869	13	accessibility	0.03448	option	0.03161
6	staff	0.03879	partnership	0.03746	14	sensitivity analysis	0.03341	sustainability	0.03076
7	product	0.03772	vehicle routing	0.03728	15	routing	0.03341	equity	0.03039
8	agility	0.03664	employee	0.03384					

Table 7: Degree centrality and betweenness centrality high ranking words in all periods.

keywords networks were divided into 6 clusters in large. This can be assumed that as it is the initial time when researchers settled down to study on HL, so they performed studies centering around several separate topics. In period 2, several loose clusters and individual nodes were sensed. This can be understood as concerns of researches were enlarged to more various areas. Seeing the map of period 3, tight network is caught. This means that the more researches were performed, the tighter density of network became. Although the shape of network map of all period looks similar to the map of period 3, it appears denser than period 3 as it considers all periods as target.

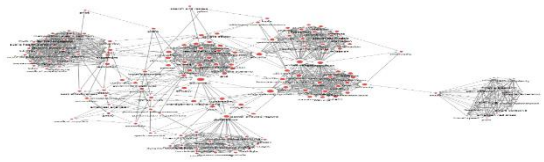
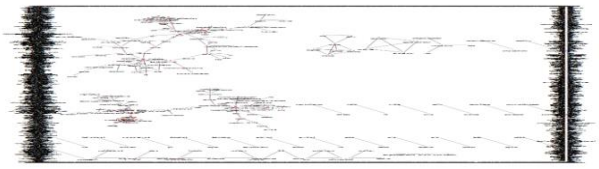
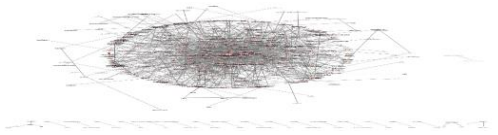
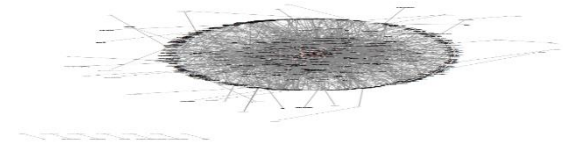
period 1 (2005-2009)	**Period 2 (2010-2014)**
	
period 3 (2015-2019)	**all periods network map (2005-2019)**
	

Figure 1: Keyword network map by period

Topic Modeling Analysis

We extracted 9 topics from HL related papers using LDA. The final topics are as follows: *coordination, preparation, sustainable development, stakeholders, recovery, facilities location, emergent response, transportation, supplying and sourcing*. Naming of each topic is done considering topic composing words and titles and abstracts of articles. Table 8 below shows the number of literatures by topics and their weight. The number of literatures of each topic is almost similar but topic 6, facilities location has most related articles of 165 following by topics, transportation and coordination. Meanwhile, topic which has the least related literatures is topic 8, recovery that accounts for 8.1% of all.

Topic	No. of papers	%
Topic1: coordination	128	12.2%
Topic2: preparation	107	10.2%
Topic3: sustainable development	98	9.4%
Topic4: stakeholders	109	10.4%
Topic5: recovery	85	8.1%
Topic6: facilities location	165	15.8%
Topic7: emergent response	94	9.0%
Topic8: transportation	146	14.0%
Topic9: supplying and sourcing	113	10.8%
Total	1045	100.0%

Table 8: Number of related literatures by topic and their ratio

Figure 2 below is visualization of topic modelling network. Through the visualized material, the structures between topics can be easily figured out which is difficult to be understood by only keywords. We could confirm that 5 of 9 topics, *sustainable development, facilities location, emergent response, transportation, supplying and sourcing* are organized individually. However, topics *coordination* and *preparation* are connected through the keyword, *manager* and topics *stakeholders* and *recovery* are connected by the keyword, *community*. In the light of these facts, *manager* is understood as the main agent of cooperation and disaster preparation and *community* is the main agent of party directly involved in HL and disaster recovery.

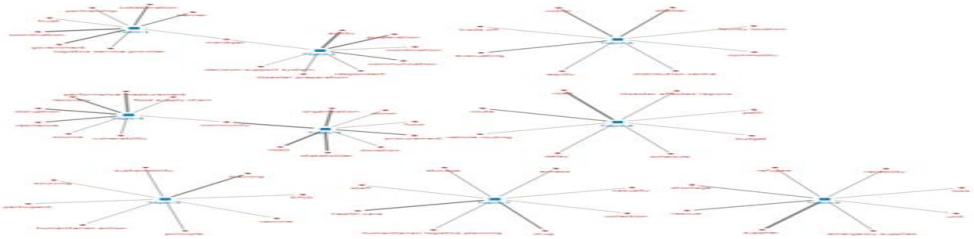


Figure 2: Topic modelling network map

Topic analysis by period

We analyzed the time-variant changes of topics by 3 divided periods as revealed in Table 9 and Figure 3. In period 1, the most dealt topic was *preparation* with weight of 21.5% followed by *stakeholders* and *recovery*. This shows that preparation and recovery were the main focus of attention in the early stage of HL researches.

Topic	2005-2009 (period1)		2010-2014 (period2)		2015-2019 (period3)	
	No.	%	No.	%	No.	%
coordination	5	7.7	33	11.1	90	13.2
preparation	14	21.5	25	8.4	68	9.9
sustainable development	6	9.2	37	12.5	55	8.0
stakeholders	10	15.4	32	10.8	67	9.8
recovery	10	15.4	23	7.8	52	7.6
facilities location	2	3.1	46	15.5	117	17.1
emergent response	8	12.3	25	8.4	61	8.9
transportation	6	9.2	42	14.2	98	14.3
supplying and sourcing	4	6.2	33	11.1	76	11.1
total	65	100.0	296	100.0	684	100.0

Table 9: No and weight of related literature by period

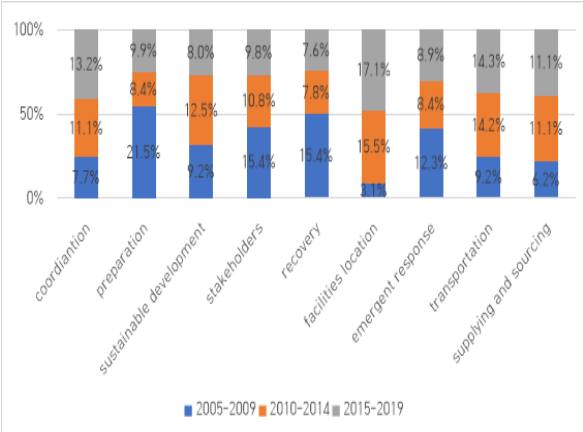


Figure 3: Bar chart of wight of literatures by period

In period 2, each portion of all topics were distributed evenly in general. However, the topic, *facilities locations* which was least addressed in period 1 was given attention the most. In addition, the ratios of topics, *transportation* and *supplying and sourcing* raised their portion as well. Judging from this, it can be verified that as researches on HL kept proceeding, the concerns on practical logistics flow were increasing. In period 3, Topics whose portions increased sharply in period 2, like *facilities location*, *transportation*, *supplying and sourcing* raised slightly or maintained their position. In case of *coordination*, the fact that it firstly came in the third place shows that it received more and more attention.

CONCLUSION

This study is significant, in the sense that it undertook research trend analysis from a new and objective perspective and is based on keyword frequency analysis, keyword network analysis, and topic modeling analysis and uses real publication data. The results herein can

be used as a stepping stone by which to set the direction for future research, by determining the research findings of HL studies in a comprehensive and macroscopic way. Results deriving from the use of these three analytical methods all demonstrated similarities and ultimately proving that these methods are significant in analyzing research trends. Nonetheless, the current study has limitations. We limited the search keywords to four types, and the analytical subjects were limited to academic papers and reviews; in this sense, we failed to analyze a large body of data. Additionally, we included the literature on HL in healthcare, and so there were certain limitations in terms of exclusively determining the logistics characteristics. Therefore, further research into trend analysis could derive more abundant search results by expanding the scope of search words (to "emergency" and "relief," for example). Furthermore, the analytical subjects could be extended to news articles, conference materials, and interviews with hands-on workers involved in HL. By comparing those results with the existing data on academic research trends and determining the gap therein, it would be possible to uncover urgent research topics that could assist in the rollout of HL. Moreover, additional studies should be conducted on HL policies, waste disposal in HL, and the customs clearance management of relief goods, all of which are topics currently known to receive less attention in academia.

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A QUALITATIVE SYSTEM DYNAMICS MODEL FOR HUMANITARIAN SUPPLY CHAIN RESILIENCE

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Purpose

Humanitarian supply chains (HSCs) face an unprecedented level of socioeconomic and sociopolitical challenges in addition to the uncertainty of global crises such as the recent COVID-19 pandemic. The purpose of this paper is to review key drivers of humanitarian supply chain resilience along the three main HSCs resilient phases (i.e., readiness, response, recovery), and to propose a system dynamic model that links operational relief resources (e.g., employees, donations, inventory) to drivers of HSC resilience.

Design/methodology/approach

This paper takes a qualitative approach from the system dynamics modeling discipline through a two-phased research design. The first phase is a review of factors affecting HSCs resilience performance under three main HSCs resilient phases. The second phase involves the development of a causal loop model illustrating the interdependencies between performance factors based on a critical literature review. Themes and concepts across qualitative data were synthesized and linked with associated variables to create interdependencies.

Findings

The proposed causal loop model demonstrates the systemic interdependencies and feedback loops between the HSCs resiliency factors that influence HSCs resilience. It is a first step in the development of system dynamics models for the assessment of HSCs resilience.

Originality/value

This paper provides insight into the conceptual understanding of causal relationships of resilience factors in humanitarian relief. It allows for a systemic level of understanding of supply chain resilience in humanitarian operations, which offers insights for practitioners to improve operational performance in presence of unexpected disruptions. The proposed causal loop model provides a catalyst for further research and discussion focusing on resiliency in HSCs.

Research limitations/implications

The model focuses on systemic relationships between resilience factors in humanitarian operations and should serve researchers and practitioners with a preliminary reference model for further development of HSCs resilience evaluation systems. The model is bounded to the qualitative aspects of system dynamics in order to visualize the feedback loop structure related to resilient HSCs.

Practical implications

The causal loop model provides a visual medium by which decision-makers can gain an overall understanding of the links between HSC resilience factors. Therefore, our model facilitates practitioners learning about dynamic complexities and multidirectional relationships between relief chain resilience factors along the three phases of readiness, response and recovery.

Keywords: Resilience, Humanitarian Logistics, Supply Chains, System Dynamics, Causal Loops, Performance Measurement.

INTRODUCTION: RESILIENCE IN HUMANITARIAN SUPPLY CHAINS

Supply chain disruptions are on the rise due to a surge in unexpected political, environmental, and other catastrophic events. The recent and ongoing COVID-19 pandemic has shown vividly the fragility of supply chain systems [1]. Even humanitarian supply chains (HSCs) which are inherently agile have been significantly disrupted due to exposure to multifaceted and compounded vulnerabilities of pre-existing constraints and operational instabilities. Disasters are inevitable, and developing resilience is the way forward to tackle and minimize unprecedented threats on supply chain systems.

With resilient HSCs designs, the objectives of humanitarian assistance could be achieved on a greater and more reliable level. In essence, improving resilience in humanitarian relief operations contributes to reliable and cost-effective aid delivery. Learning from current and past disruptions and developing contingency planning will strengthen HSCs resilience for future events. Establishing resilient HSCs operational procedures is a key strategy to overcome and control the disruption resulting from large-scale disasters and therefore enhancing the overall HSC performance.

Existing literature on HSCs resilience focuses on the combined impact of agility and resilience on the performance of HSCs [2], implementation of blockchain technology for enhancing HSCs resilience [3], collaboration in relief supply networks [4], analysis of major strategies for resilience in HSCs [5] and development of a redundancy framework for countering the risks inherent in HSCs disruptions [6]. While existing literature provided insights into HSCs resilience approaches in humanitarian relief operations, they are limited in scope and number. The literature indicates is limited to understanding strategies that enable resilience of HSCs and provide limited information on the key drivers of HSC resilience. Furthermore, the literature does not provide directions on how to evaluate the resilience of humanitarian relief operations.

In addition, the examination of causal relationships among different HSCs resilience factors have remained largely unaddressed. Understanding the causal interdependencies among resilience factors will help practitioners in developing strategies towards more resilient HSCs. Hence, motivated by the unexpected challenges and supply chain interruptions caused by the recent COVID-19 pandemic, and given the limited existing scholarly work on resilient HSCs, this paper aims to propose a structured framework for identifying, clustering, modeling, and assessing factors of resilient HSCs. This paper also examines the interdependencies of performance factors of resilient HSCs. It builds on lessons learned from supply chain disruptions to develop a conceptual framework for evaluating and improving supply chain resilience in humanitarian settings.

RESEARCH DESIGN

We designed our research method around two main phases. Phase 1 provides context to the problem and focuses on the formulation of resilient HSCs factors. Phase 2 involves the development of a causal loop model illustrating the interdependencies of performance factors of resilient HSCs.

Phase 1. Identifying and categorizing the resilient factors

Phase 1 identifies and categorizes the resilient HSCs factors. To determine and formulate these constructs, we retrieved and reviewed related articles from major scientific databases using keywords such as "HSCs", "humanitarian logistics", "humanitarian operations", "resilience", "performance measurement", and "performance indicators". We have also reviewed relevant literature with a direct focus on performance measurement of resilient supply chain operations. Based on the collected information, we formulate the most relevant HSCs resilience factors.

Phase 2. Development of a causal loop model for interdependencies of resilient factors.

This phase encompasses the development of a causal relationship model that captures the links among the resilient factors and refines the identified resilient factors in phase 1.

We first identified the major causal relations and interdependencies between performance factors found in Phase 1, and then formulated them into a causal loop model. To develop the model, we follow a causal loop diagramming approach [7] to demonstrate the interdependencies using feedback loops.

RESILIENT HSCS PERFORMANCE FACTORS

Table 1 presents the HSCs resilience performance factors we identified through our literature review and categorizes them into the three phases of relief operations (readiness, response, recovery).

*Table 1. HSCs resilience factors**

Phase of relief operations	HSCs resilience dimensions	Performance factors
Readiness	Donations and earmarked funds independency (C_1)	Percentage of program portfolio planned with funds reservations and precommitments with key stakeholders, good knowledge of donor behavior for earmarked and unearmarked funds.
	Volunteer and community resilience management (C_2)	Percentage of trained relief staff and volunteers in basic case management of pandemic cases, Number of staff trained in the use of the UN pool procurement portal, average number of hours spent on volunteers' training.
	Visibility and situation awareness (C_3)	Tracking and monitoring of crowdsourcing using Geographic Information System (GIS), artificial intelligence-based beneficiaries need assessments
	Pre-established and advanced support systems (C_4)	Percentage of prepositioned personal protective equipment (PPEs), face masks, O2 capsule in countries prone to epidemics and pandemics, functioning logistic supply monitoring system for pandemics, number of interactions using Blockchain Technology (BT), Percentage of designated points of entry with screening, isolation facilities and referral system for pandemics.
	Security management (C_5)	Access restriction, personnel security, public-private security partnership, level of personnel protection against kidnapping, maintaining an incident map, level of corruption.
Response	Collaboration and information sharing (C_6)	Country with a functional multi-sectoral, multi-partner coordination mechanism for pandemic preparedness and response, Degree of information sharing and cooperation, degree of supply chain ICT utilization, collaborative need assessment forecasting and risk-sharing.
	Agility (C_7)	Average number of days that material is unable to be supplied, Number of days with stockouts of PPEs, total on-hand stock level in the whole network across all distribution centers and products averaged over the time horizon, lead time ratio, stock-out rate, inventory accurate rate.
	Flexibility (C_8)	Flexibility in customization of relief goods to the beneficiaries' requirements, volume flexibility,

		distribution flexibility, flexibility in sourcing and order fulfillment, flexibility in change transport modes or routes.
	Leadership (C_9)	Cooperative and intergroup humanitarian leadership style.
Recovery	Knowledge management (C_{10})	Number of social media messages on COVID-19 shared weekly on social media platforms, use of social media and virtual communities of practices, dynamic taxonomies for complex configuration for rapid and accurate knowledge sharing, incorporate local and indigenous knowledge for social recovery resilience, average hours spent on training staff, percentage of staff with certification (or comparable) qualification.
	Contingency planning (C_{11})	Recovery time, reconstruction of the supply chain, supply chain reconfiguration
	Financial efficiency (C_{12})	Stability ratios, capacity (liquidity) ratios, fundraising, expense ratio, total transportation and warehousing costs post-disaster, deviation from project budget, overhead cost.

**Due to space constraints, we were not able to list the references supporting each of these causal relationships, however we will include them in a full paper and can provide the detailed list upon request.*

The next subsection discusses the resilience factors for each phase of relief operations.

i) Readiness

HSCs resilience performance factors in the readiness phase focus on operational aspects that enable Humanitarian Relief Organizations (HROs) to reduce delays and focus on effective and on-time delivery of relief in case a disaster occurs. Preestablished supply chain mechanism such as prepositioned inventory and equipment, flexible and adaptable supply chain configuration, decentralized fleet of vehicles, and advanced and digital technologies (e.g., 3D printing, drones, big data analytics, and industry 4.0) would significantly enhance the resilience of relief operations [8,9]. The related performance factors are discussed below.

a) Donations and earmarked funds independency

Donation and earmarked funds play a significant role in supporting humanitarian missions, while at the same time posing a pressing constraint and challenge for HROs. Funding not only determines the scope and size of humanitarian operations, but also has a crucial influence on the efficiency and speeds of the operations. It is therefore essential for HROs to be able to engage with donors for creating mutual understanding about the need for flexibility of spending, and developing independence for special donations and earmarked funds. Earlier research has confirmed that flexible use of funds is highly important to HSCs and its performance as highlighted in [10].

b) Volunteers and communities resilience management

Earlier studies have indicated that the highly resilient communities are those that possess an inclusive range of cooperative organizations, often made up of volunteers such as doctors, educators, and religious leaders [11]. Successful community's resilience centers on how a disaster is framed by the community and its leaders and how cooperative the community is in dealing with challenges [11].

c) Visibility and situation awareness

In disasters and unpredictable emergencies, the availability of reliable information for decision-making is critical for saving lives. Situational awareness and data-driven decision-

making using Artificial-Intelligence (AI) has become increasingly popular among leading international HROs to develop resilience and flexibility for upcoming disasters [12]. Predictive analytics and AI-based solutions can be applied for humanitarian response to predict the number and type of relief goods when a disaster strike [12].

d) Pre-established and advanced support systems

Due to high level of uncertainty in disaster operations, pre-disasters logistical procedures and mechanism such as prepositioned inventory and equipment significantly enhance the efficiency and effectiveness of relief operations [13]. In addition, the use of advanced and digital technologies (e.g., 3D printing, drones, blockchain, big data analytics, and virtual reality) enables HROs to overcome challenges such as inaccurate needs assessment, inconsistent and outdated information sharing, inability to track resources, thereby increasing the reliability and resilience of the relief operations.

e) Security risk management

Humanitarian operations security management relates to operational and contextual risks, and utilizing effective risk management measures to facilitate safe program delivery [14]. Security management measures relate to access restriction, cyber-security, personnel security, Standard Operating Procedures (SOPs) to mitigate the threats identified in the risk assessment, security partnership with other NGOs, physical security and evacuation plans.

ii) Response

The response is the most critical phase of relief operations. The resilience of HSCs during the response phase concerns mechanisms that enable on-time delivery of relief aid and maintains relevancy to beneficiaries' requirements.

a) Collaboration and information sharing

A collaborative partnership among actors in humanitarian settings helps to anticipate disruptions and manage risks efficiently [13]. Several researchers emphasized supply chain collaboration to be an important factor for HSCs resilience [13]. Collaboration and information sharing minimize the risk of duplication and waste of resources in disaster relief.

b) Flexibility and agility

Flexibility and agility are both essential components of developing supply chain resilience. However, flexibility, agility, and resilience seem to have overlapping definitions and construct as discussed in [15]. Studies have shown that flexibility is a requirement and a foundation to achieve supply chain agility and resilience in humanitarian operations. Performance factors related to flexibility comprise a mix of volume, product, and delivery flexibility. Agility performance factors are related to completeness, reliability, velocity, reactivity, and visibility.

c) Leadership

In the humanitarian sector, leadership plays a significant role in improving relief operational performance [16]. In the context of HSCs resilience, leadership has a direct influence on intra-organizational cooperation, and is as a key enabler of how leadership improves operations. Studies have shown that a strong leadership management style that recognizes distinctive sub-organization relief workers group's behavior enables a cooperative environment within and beyond the humanitarian organizations' boundaries, would enhance cooperation among HROs and in turn facilitates resilience of relief chain operations.

iii) Recovery

Returning to normalcy through reconstruction and restoration of infrastructures after the initial response phase is the prime focus of the recovery phase. It is therefore necessary to explicitly consider the recovery phase during the readiness and response phases, as this will avoid potential problems that may arise after a disaster.

a) Knowledge Management

Knowledge Management (KM) resources (i.e., IT assets and capabilities, cultural KM resource, and human KM resource) have been identified as key enabling factors for supply chain resilience [17]. KM facilitates knowledge sharing and cooperative trust among involved organizations and communities. It facilitates the development of resilient collaborative relationships through inter-organizational learning, post-disaster feedback to develop knowledge about risks, and cost/benefit analysis. As a result, KM increases the reliability and the efficiency of the overall disaster situational awareness.

b) Contingency Planning

Planning includes written contingency plans and procedures to respond to anticipated disaster situations. Standard Operating Procedures (SOPs) that guide staff to mitigate the threats identified in the risk assessment is crucial aspect of contingency planning. Contingency planning should include national and local SOPs for responsibilities, priorities, and key relief operations based on scenarios related to severity and level of disaster damage caused. These SOPs should coordinated with the governmental organizations and authorities, as well as operating them independently.

c) Resilient Financial Efficiency

The impacts of good financial management and efficient funding systems on the resilience and operational performance of HROs have been thoroughly discussed in [10]. It is highly crucial for HROs to maintain steady and stable service provision by ensuring a strong balance of funding sources (i.e., grants, donation, fund-raising activities) [13]. A diverse and stable funding stream enhances financial resilience and positively affects the survival prospects of the HROs.

THE INTERDEPENDENCIES OF HSCS RESILIENT PERFORMANCE CONSTRUCTS

The HSCs resilience assessment focuses on developing a conceptual causal loop model of the system that identifies interdependencies and the boundaries of performance factors related to HSCs resilience. We propose a causal model of the interdependencies of resilient HSC factors based on literature review. The literature review performed for this study allows us to develop a causal model of the interdependencies of resilient HSC factors.

*Table 2. Examples of causal relationships for resilient HSCs factors in the reference model**

Phase of relief operations	Causal relationship between resilience factors	Direction **+/−**
Readiness	Blockchain Technology (BT) → Swift trust	**+**
	Operational supply chain transparency → Swift trust	**+**
	Blockchain Technology (BT) → Visibility and situation awareness	**+**
	Blockchain Technology (BT) → Financial efficiency	**+**
	Blockchain Technology (BT) → Flexibility	**+**
	Skilled and competent volunteers → Collaboration	**+**
Response	Swift trust → Collaboration	**+**
	Information sharing → Swift Trust	**+**
	Information sharing → Visibility and situation awareness	**+**
	Collaboration → Agility	**+**
	Collaboration → Contingency planning	**+**
	Intra-organizational barriers → Blockchain Technology (BT)	**-**
	Agility → Collaboration	**+**

	Agility → HSCs performance	+
Recovery	Knowledge management → HSCs resilience	+
	Knowledge management → Visibility and situation awareness	+
	Contingency planning → Improved HSCs resilient performance	+
	Contingency planning → Collaboration	+
	Contingency planning → Knowledge management	+
	Resilient financial efficiency → HSCs resilience	+
Outcome (resilient HSCs)	HSCs resilience → HSCs performance	+
	HSCs agility → HSCs performance	+
	Collaboration → HSCs resilience	+

**Due to space constraints, we were not able to list the references supporting each of these causal relationships, however we will include them in a full paper and can provide the detailed list upon request.*

The model incorporates variables pertinent to HCSs resilience and aims to summarize key findings from the reviewed literature. The causal loop diagram presented in Figure 1 was developed by identifying key variables affecting the resilience of HSCs (from the literature) and mapping their interdependencies, using the software Vensim. Themes and concepts identified in the literature were synthesized and linked with associated variables to create the interdependencies. We extend the boundaries of the model by identifying links and delays that may exist between variables. The model provides a high-level view of the resilient HSCs. It covers the three phases of the relief operation and demonstrates the causal relationships among variables that drive the resilient HSCs performance.

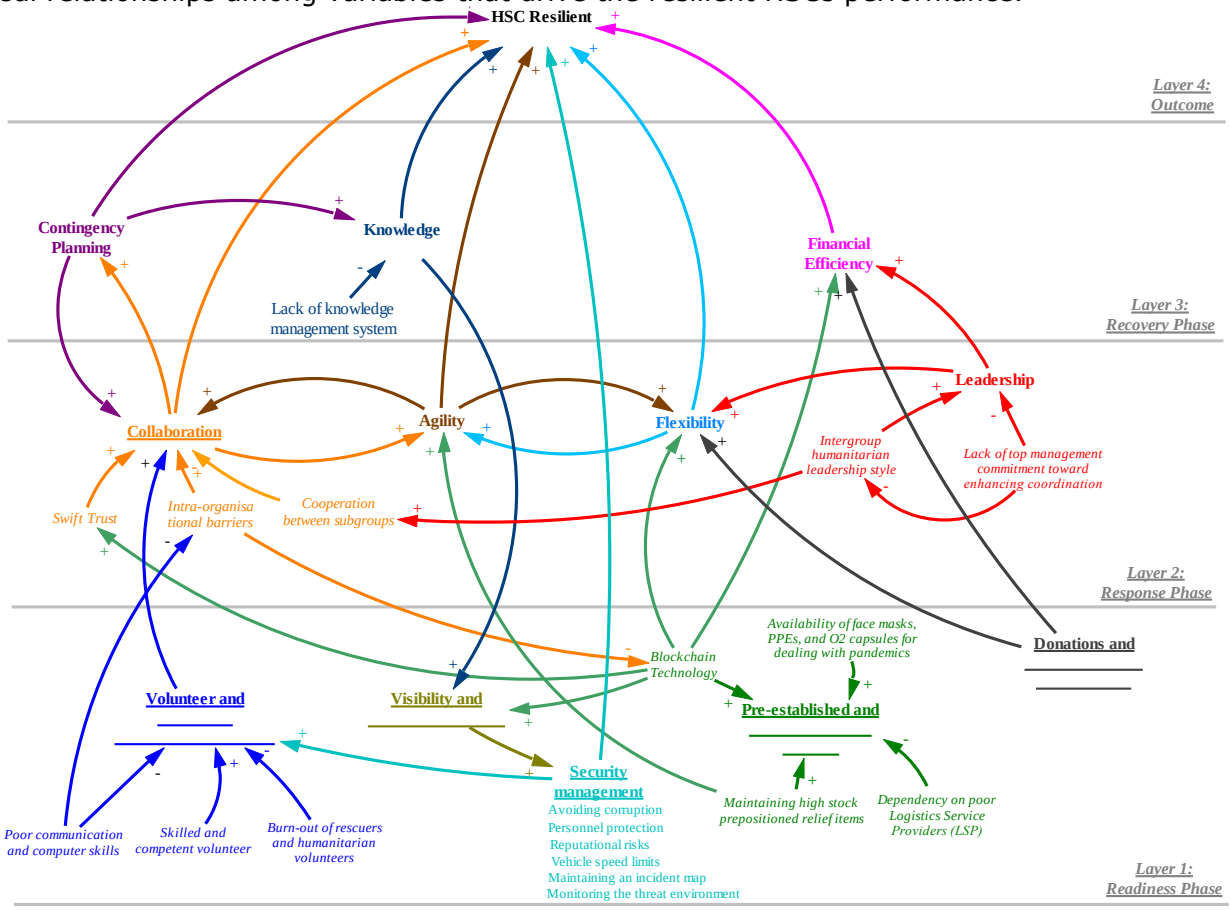

Figure 1. A reference model for interdependencies of resilient HSC factors

DISCUSSION AND CONCLUSIONS

This paper aims to identify key factors of resilience in HSCs and develop a reference model for resilient HSCs. The developed causal loop model demonstrates a number of important interdependencies and feedback loops between resilient HSCs constructs. The proposed model complements existing causal loop models in humanitarian relief, by providing insights about the interrelations between factors of resilience in HSCs.

Our paper has a number of implications for practice and theory. The model presented in this paper contributes to a deeper understanding of resilience factors and their causal interdependencies, which in turn influence the HSCs resilience. These factors are fundamental for preparing for and managing disruptions in a complex and uncertain environment such as humanitarian relief operations. The model provides an initial reference for future theoretical and empirical developments for dynamic modeling and analysis of resilience in disaster relief. In terms of practical implications, the proposed model facilitates practitioners' learning about dynamic complexities and interdependencies between variables involved in HSCs resilience.

The proposed model helps to identify key processes that determine resilient HSCs performance and therefore, supports HROs decision making using a set of key factors of resilience. The factors in the model are presented through a causal loop diagram, which helps to describe the system's structure and behavior in an intuitive way. However, future studies could extend the model and focus on quantitative analysis of an HSC resilient assessment.

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ICT ENABLED APPROACH FOR HUMANITARIAN DISASTER MANAGEMENT: A SYSTEMS PERSPECTIVE

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ABSTRACT

Purpose of this paper:
Each stage in the disaster management faces different challenges concerning information gathering, interpretation and dissemination. However, a comprehensive understanding of different Information and Communication Technology (ICT) systems utilised for humanitarian disaster management is limited. The paper follows a systems thinking approach to examine major man-made and natural disasters to comprehend the influence of ICT systems on humanitarian relief operations.

Design/methodology/approach:
A longitudinal, multi-case study captures the application spectrum of ICT systems for relief operations over the past two decades. The paper follows a systems thinking approach to examine ten major man-made and natural disasters to comprehend the influence of ICT systems on humanitarian relief operations.

Findings:
Multiple ICT tools such as geographic information systems, online webpages/search engines, social media, robots, artificial intelligence are being used for rapid disaster response and mitigation. Speed and coordination of relief operations have significantly increased in recent years due to increased use of ICT systems.

Value:
Broadly classifying the ICT systems into surveillance, decision support and broadcasting systems, a novel ICT-enabled model for humanitarian relief operations is developed.

Research limitations/implications:
In this research, secondary data on multiple past disasters is used to derive inferences and propose ICT-enabled model for humanitarian relief operations.

Practical implications:
A holistic understanding of a complex inter-relationship between influential variables (stakeholders, disaster stages, zones of operation, ICT systems) is beneficial for the effective management of humanitarian disasters.

1. INTRODUCTION

The significance of the humanitarian disaster management is rising due to increased frequency of the disasters since the 2000s. The increased mismatch between humanitarian needs and the availability of resources demands efficient disaster relief operations (Heaslip, 2018). Disaster management is all about reducing the risk of impact and coping with human lives and economic loss (Quarantelli, 1988). United nation's office for the coordination of humanitarian affairs (OCHA) has developed humanitarian information systems (e.g., ReliefWeb), the regional information networks and humanitarian information centres.

A robust information management systems are critical to the success of disaster management (Yates and Paquette, 2011). Information and Communication Technology (ICT) has the potential to deliver clear, accurate and instant information for the relief operations (Gomez and Elliot, 2013). According to Li et al. (2012), ICT is an emergency responding mechanism filling the communication gap in the disruptive event situation.

Approaches for building ICT network for early warning has lacked in the humanitarian disaster management research (Sagun et al., 2009; Meier, 2011). Real-time information could increase the accuracy of priority-decision-making and inter-sectional communication. Once the disaster strikes, communication accessibility is always the challenge for the relief organisations. In such situations, ICT acts as an informational connection between disaster management actors and affected population (Price and Richardson, 2011; Palen et al., 2007). However, ICT suffers from information bottlenecks, lateness and inaccuracies hindering the efficiency of the relief operations and causing long delays in receiving humanitarian aid (Greenough et al., 2011).

Disaster management involves complex settings, which may be influenced by multiple factors (Coetzee and van Niekerk, 2012). Improving humanitarian disaster management is becoming critical due to an increasing number of disasters (Altay and Green, 2006; Dubey et al., 2019). However, limited studies focus on the development of models for humanitarian disaster management (e.g., Maon et al., 2009; Charles et al., 2010). In the past, individual disasters have been explored to understand the role of information sharing in the humanitarian relief operations (e.g., Bharosa et al., 2010; Altay and Labonte, 2014). However, they lack in capturing the bigger picture in terms of information gathering, interpretation and dissemination, particularly in the current era of a mobile and social network. A multi-case study exploring the application of ICT, utilising mobile and social network for humanitarian disaster management is lacking in the humanitarian supply chains as well as disaster management literature. Therefore, this study attempts to develop a comprehensive ICT-enabled model for efficient humanitarian disaster management following the understanding of different ICT systems and associated networks utilised in past humanitarian disasters. The study aims to capture the development of ICT applications in past humanitarian disasters and develop a model for humanitarian relief operations.

This paper adopted systems thinking approach to extract ICT tools, applications and practices used in the selected disaster cases. Systems thinking approach is suitable to investigate an unstructured situation (Checkland, 1981; Checkland and Scholes, 1990). It is a problem-solving approach for 'difficult to model' problems and helps to build cause-and-effect relationships (Ghadge et al., 2020; Er Kara et al., 2020). Soft-systems thinking approach is recommended to be used in complex, dynamic and interlinked contexts (Sushil, 2000; Khyrina et al., 2012). Hard-systems approaches based on simulation and modelling are apt for analysing quantitative data.

According to Cavallo and Ireland (2014), disaster relief operations are based on the hierarchy (top-down) model and cannot identify the nature of challenges. Complex phenomena such as disasters present many emergent and cascading effects (Helbing, 2013). The information available from these events are insufficient to perform statistical analysis (Ruggeri et al., 2005); as disasters are characterised by interdependent activities, whose impacts are difficult to predict (Lorenz et al., 2009). Thus, soft-systems thinking is found to be a suitable methodological approach for the given problem.

2. LITERATURE REVIEW

Academic literature on the disaster management discussing definitions, processes and associated activities are evident (e.g. Nisha de Silva, 2001; Cottrill, 2002; Pettit and Beresford 2005, 2009). Disasters can originate from natural or man-made sources or a combination of both. Safran (2003) developed the 'disaster cycle' involving four phases as prevention, disaster/emergency, transition and recovery. Information sharing and closer collaboration are inevitable for efficient disaster management (Kovács and Spens, 2009). Recently, Scott and Batchelor (2013) developed a disaster management cycle by linking processes with information. The disaster cycle consists of mitigation and preparedness as stages for pre-disaster management, and responsiveness and recovery stages for the post-disaster management. Most importantly, preparation and coordination are vital for operational excellence in disaster management (Botchie et al., 2019). Different activities involved in each stage/process may vary depending upon the nature and complexity of the disaster. Accurately identifying risks and providing timely information is crucial for disaster management (Kovács and Spens, 2009). Disaster management has inherent challenges,

which may originate due to the lack of knowledge about where and when a disaster will occur, geographical extent and the impact of the event (Van Wassenhove, 2006).

3. RESEARCH METHODOLOGY

Systems thinking is a methodological approach attempting to understand how multiple dimensions interact with one another and how they can be brought into an appropriate relationship for the improved results (Sterman, 2000). Systems thinking follows case studies and Soft Operations Research (OR) studies in developing conceptual or mental models (Forrester, 1994). The complex models emerging from the initial description of the real system are then modelled for the evaluation.

Systems thinking is an approach to understanding interaction and impacts within different components to address complicated problems and deal with every issue as an element of a large system. The soft-systems thinking model would measure how the primary cause (ICT) is associated with different subsystems (Ackoff et al. 2010). According to Forrester (1994), systems thinking integrates case studies in improving complex conceptual models emerging from the basic description of the real system. The key benefit of systems thinking is its ability to deal effectively with problems that are marked by complexity and multiple interdependencies. Past disaster cases are used in this research to study the link between ICT and disaster management and are assessed using a systems thinking approach.

Key insights of disaster management literature are structured using the paradigm of SAP-LAP (Sushil, 2000). The synthesis presented in Figure 1 captures situations, actors and processes. The situation represents disaster situations such as natural and man driven disasters. Actors represent agencies involved in planning and managing disaster activities. Processes represent activities involved in relief operations such as the supply of food, medicine, shelter and cloths. These relief operations are performed across overlapping phases of the disaster management cycle. Indeed, disaster management is a complex system interacting with multiple factors/subsystems for 'systemic' learning, action and performance.

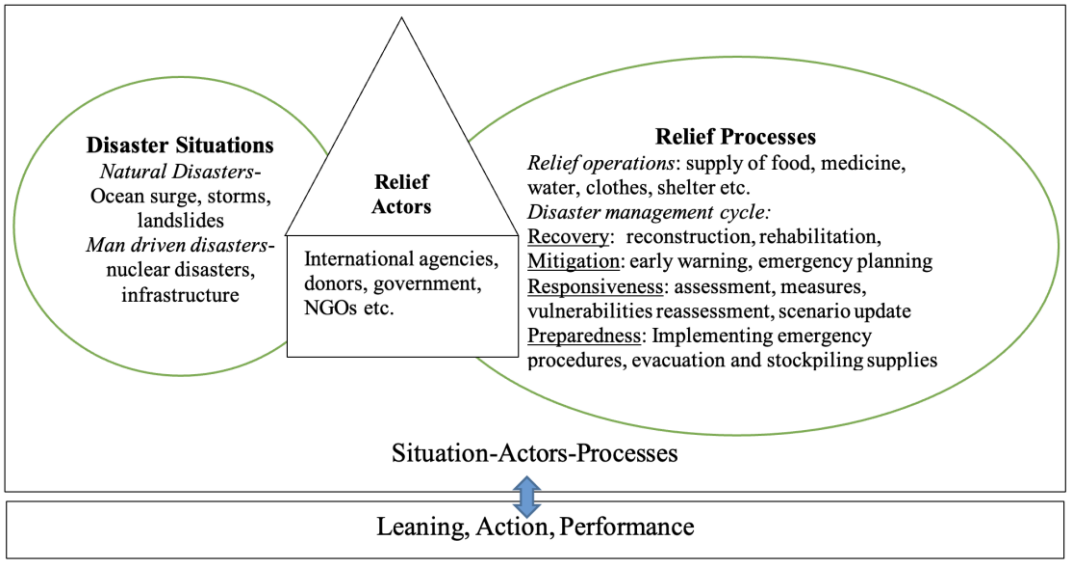

Figure 1: Situation, actor and process perspective of disaster management

In this research, natural and man-made disaster data for the past decade is methodically studied (Table 1) to understand a different set of activities involved during each stage of the disaster cycle. Secondary data on past natural as well as man-made disasters, were collected over the last twenty years (2000-2020). Cases were chosen to comprehensively cover natural disasters such as river flood, earth quack, cyclone, hurricane tsunami, biological calamity, etc. as well as man-driven disaster such as 9/11

attack and pandemic. The secondary data consisted of cross-historical sources such as regional and international news, international/governmental relief reports, journal articles, documentary films, internet sources and textbooks. The secondary data provides transparency to the data collection process; as the untiled data is available for everyone (Papachroni and Lochrie, 2015). The case study method is a combination of multi-sources, and it contains a large amount of data to interpret some in-depth phenomena, but follows replication logic (Drake et al., 1998; Yin, 2009). The data was methodically collated the secondary data on chosen cases. The longitudinal, multiple-case study approach attempted in this study is expected to capture the likelihood and pattern of the previous operations to better understand the interaction between ICT tools and stakeholders in disaster. Increased use of ICT (including social media) for disaster management has been a primary reason for choosing disaster cases beyond the year 2000. A longitudinal study is expected to provide information related to shifts in technology and their use of modern ICT tools.

Table 1. Overall impact of selected disasters (multiple sources#)

Disaster	Type	Death and causality	Relief span	Impact of disaster	Learning from relief operations
9/11 attack (2001)	Man-made (quick onset)	2996 deaths and more than 6000 injuries; 1064 of first responders died from respiratory cancer.	Estimated 9 months ((The debris and wastes were removed till May 2002)	The threat of war after the attack – drove down the Dow for 600 points It formed the military campaign in Afghanistan.	– Poor capacity of critical infrastructural support such as elevators. – Sudden congestion in bandwidth of telecommunication channel. – Poorly designed communication channel in public service departments – Use of GIS in matching demand with supply
Indian Ocean Tsunami (2004)	Natural disaster	Total death 226564 (Indonesia 165708; Sri Lanka 35399; India 16839; Thailand 8345; Maldives 102; Malaysia 80; Myanmar 71); 1.3 million people affected.	At least 5 years to see everything is improved	$ 8.71 billion 5-6 million people needed food and water	– Inadequate infrastructure to support various emergency operations – Use to software-enabled bulletin-board to search for missing people – Use of GIS in conjunction with a humanitarian map
Hurricane Katrina (2005)	Natural disaster	1833 (mostly in Louisiana, and 50% of victims were above the age of 74) and 273,000 displaced	At least 5 years	$ 105 billion 800,000 housing units destroyed or damaged	– Dependence of commutation channel on ground situation such as water, wind etc. – Dependence of coordination and collaboration on communication channel. – Use of SMS and VoIP to communicate – Solar/battery power equipments.
Cyclone Nargis (2008)	Natural disaster	138,366 dead, 2.4 million affected	Over 4 years	$10 billion Lacking food and water	– Lack of ICT tools – Poor capacity of government and exclusion of foreign help

				Many children became orphaned Diseases were prevalent after the cyclone.	
Haiti earthquake (2010)	Natural disaster	220000 dead, 300000 injured and 3500000 affected	More than 5 years	$7.8 billion (Haiti's GDP in 2008 was $11.6 billion) The capital city was badly damaged as well as civil service.	– Poor infrastructure – Limited communication system – Ambiguous roles and responsibilities in public agencies – Use of web, SMS and social networks for communication
Pakistan Floods (2010)	Natural disaster/ Man-made	1985 deaths and more than 1 million displaced	At least a year	$ 43 billion 2.5 million people suffered a high risk of starvation	– Inadequate integration in GIS and various communication networks – Use of SMS, GPS for locating and evacuation.
Japan Earthquake (2011)	Natural disaster/Man-made	15894 deaths, 6152 injured, and 2562 missing; estimated over 300,000 displaced	Still ongoing (because of the nuclear plants explosion)	Slow and ambiguous reaction caused Fukushima nuclear crisis $ 14.5 to 34.6 billion	– Successful use of early warning system – Use of satellite images for evaluation and planning. – Use of social media network sand email for communication.
Typhoon Haiyan (2014)	Natural disaster	6201 deaths, 4,095,280 displaced, and 1061 missing	Over 4 years	$ 2.86 billion 41000 housing destroyed Prevalence of diseases	– Development of emergency telecommunication cluster to support destroyed communication services.
Ebola virus disease (2014-15)	Man-made	11,310 deaths and 28616 cases	5 Years	GDP in Guinea dropped 1%; Sierra Leone's economy deflated by 30% 16000 children lost parents or caregivers	– ICT based education and information sharing – Use of ICT for mapping of health-risky areas

COVID-19 pandemic (2020)	Man-made	Over 26 million affected globally and led to 1 million deaths	Ongoing	Global shutdown of borders 5.2 % contraction in global GDP Expected Global recession	– ICT based education and information sharing – ICT based contact tracing applications – Use of drones and robots to monitor lockdown and mitigate the spread

#Source of information for each disaster is available with the author.

Table 1 collates the information on the overall impact of (man-made and natural) disasters. The choice of disaster cases was primarily driven by its wider impact and ICT use on relief operations.

4. MULTI-CASE LONGITUDINAL STUDY

Analysis

Disasters can originate from different sources, and the impact of such disasters depends on the extent of its geographical spread. The speed of onset is the quickness at which the disaster strikes a region. Some of the natural disasters like earthquake, hurricanes, tornados and tsunamis tend to occur suddenly, devastating the entire region. Whereas some of the calamities like famine, pandemics, heat waves, etc. tend to cascade its impact gradually and may be localised or cover large regions. Disaster management requirements for each event are different and hence, it is important to consider a holistic (also referred to as systems) perspective for identifying appropriate ICT based approaches for the disaster management. During the disaster recovery process, ten important activities are identified by Médecins (1997), and this covers some of the key activities such as initial assessment, provision of water, food, shelter, health care and the control of epidemics. All these activities require information sharing tools to coordinate between disaster response teams and global volunteers. Before 1990's humanitarian disaster operations were managed with the help of radios, paper forms and clipboards (Portsea, 2011). However, post-2000, the internet era has brought new tools, techniques and mobile/digital networks to manage the humanitarian disasters better. The following section discusses selected ten cases to generate insights into ICT systems, applications, challenges and practices.

Following soft-systems thinking approach, multi-cases were analysed holistically. Unique and common variables were identified from the cases to develop holistic understanding. Some of the common themes originating from the multi-case study are presented as learning. Table 2 presents the progression of ICT systems over the past 20 years for humanitarian relief operations. Evidently, since 2010, the ICT application has increased the use of internet/social media-related tools for first-hand information gathering, which increases the accessibility of information diffusion and exchange during operations. Increased social connectivity through twitter, messenger, Facebook, etc. has further led to increased awareness regarding different relief operations. With the advent of modern search technology, online search systems and warning systems are also found to be primarily/key sources of data collection and sharing. In spite of all these developments, the GIS is found to be the most common and reliable ICT tool used for disaster relief operations.

Table 2. Longitudinal development of ICT tools for disaster management

Year and ICT use for disaster management
2001
• Radio
• Mobile phone/cellular network
• Phone line
• GIS mapping
2004
• Online relief website (Shahana)
• GIS
• Satellite imagery
• DART II
2005
• Mobile phones and SMS
• Online webpage (BoingBoing)
• Radio and some other communication devices
2008
• Myanmar information management (MIMU)
• GIS

2010
- Mobile phones and SMS
- Phone line
- Online Database webpage (Ushahidi)
- Social networks (google groups)
- GIS
- Basic telecommunication infrastructure

2011
- Satellite imagery
- GIS
- Some social media networks
- Tsunami early warning system

2014
- Radio station
- Online community webpage (Google person finder)
- Social media (Twitter)

2015
- GIS with online webpage service (Humanitarian OpenStreetMap)
- Mobile phones and SMS
- Social media
- Online Database webpage (healthmap.org)
- ERCI project – Wi-Fi with satellite service

2020
- Mobile phones and SMS (e.g., NHS app for pandemic)
- Digital interactive maps (Worldometer, Healthmap)
- Social media for health alerts (Facebook, Twitter, WhatsApp, Weibo).
- Online Dashboards/ webpages (healthmap.org)
- Robot and drone technologies

Figure 2 shows the application spectrum of ICT applications and the bars shows the exploitation of such utilities in the specific time horizon. It can be observed from the figure that, GIS and online webpages/search engines are the most popular tools used for assessing the disasters. Mobile phone/SMS, and satellite imaginary are also commonly seen to be used in the disaster responding. Use of social network platforms has increased exponentially over the past 5 years for information gathering and dissemination. More recently, Artificial intelligence is used for data analysis to make critical decisions. Digital technologies such as robots and drones, 3D printing were also distinctly used for quick disaster response.

The phone line service and radio were not seen to be commonly used since 2000; although they played a vital role in pre-2000 disaster management. Such conventional communication and information exchanging devices are mostly replaced by online or wireless devices like online service, mobile networks and satellite services. Although, SMS/mobile service is still commonly and preferred means for information sharing; it could be inferred that today's information and communication systems are majorly emphasising on wireless technology, as it can instantly communicate and transmit information without actual infrastructure.

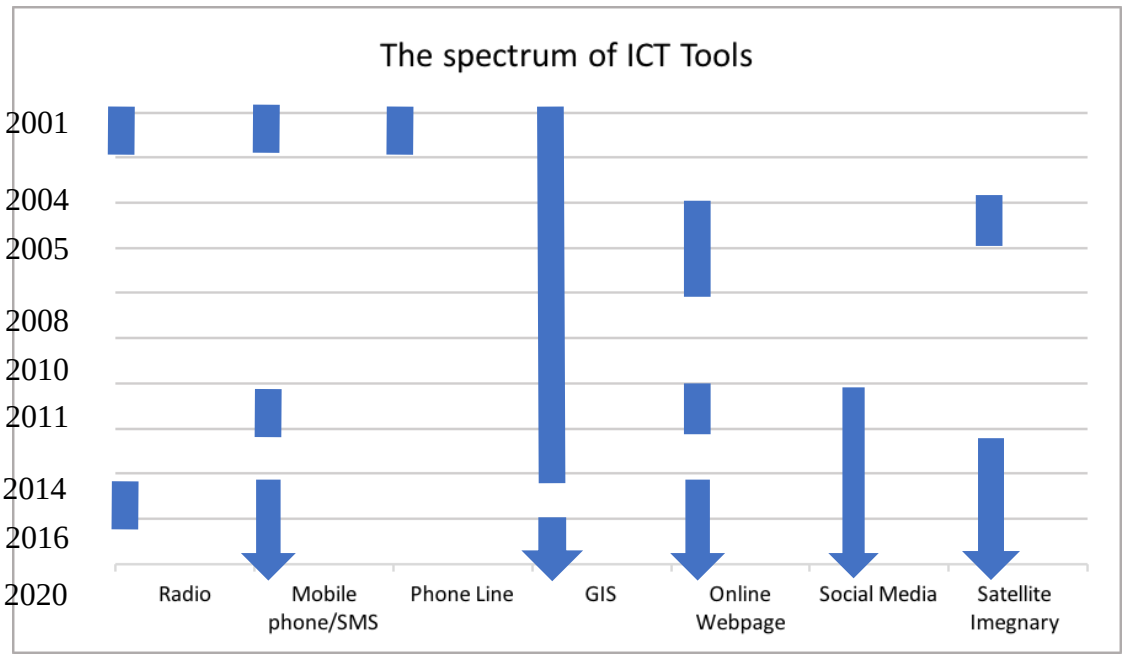

Figure 2. The application spectrum of ICT tools

Framework development

From a management perspective, the above ten case studies represent the need for coordination between stakeholders, technology use, stage of disaster and zone of operation. A centralised system able to coordinate and share information between different elements involved in disaster management is lacking. With several people affected due to disaster, it is difficult for a single system to manage the recovery process. The lack of integrated systems for disaster management demands a common platform for seamless information flow (Dorasamy et al., 2013). It is evident through this multi-case study that the involvement of stakeholders and the ICT system varies during pre and post-disaster stages. The zone of operations is also believed to be an important consideration (evidenced through the discussed cases), as the size of the affected region, the terrain and the nature of calamity critically drives the effectiveness of disaster management. A coordinated approach between all these identified entities can provide efficient ICT based disaster management process.

Utilising some of the insights generated regarding ICT systems, stakeholders involved, disaster stages and zones of operations, a conceptual framework for ICT based disaster management is proposed. Following a systems thinking, Figure 3 captures key elements involved in each entity and their association with each other. The building block of the ICT disaster management framework (Figure 3) is based on the processes involved in a disaster management cycle, namely- mitigation, preparedness, responsiveness and recovery. From a supply chain perspective, each relief operation is geared towards matching the demand of displaced/affected people with a supply of relief resources.

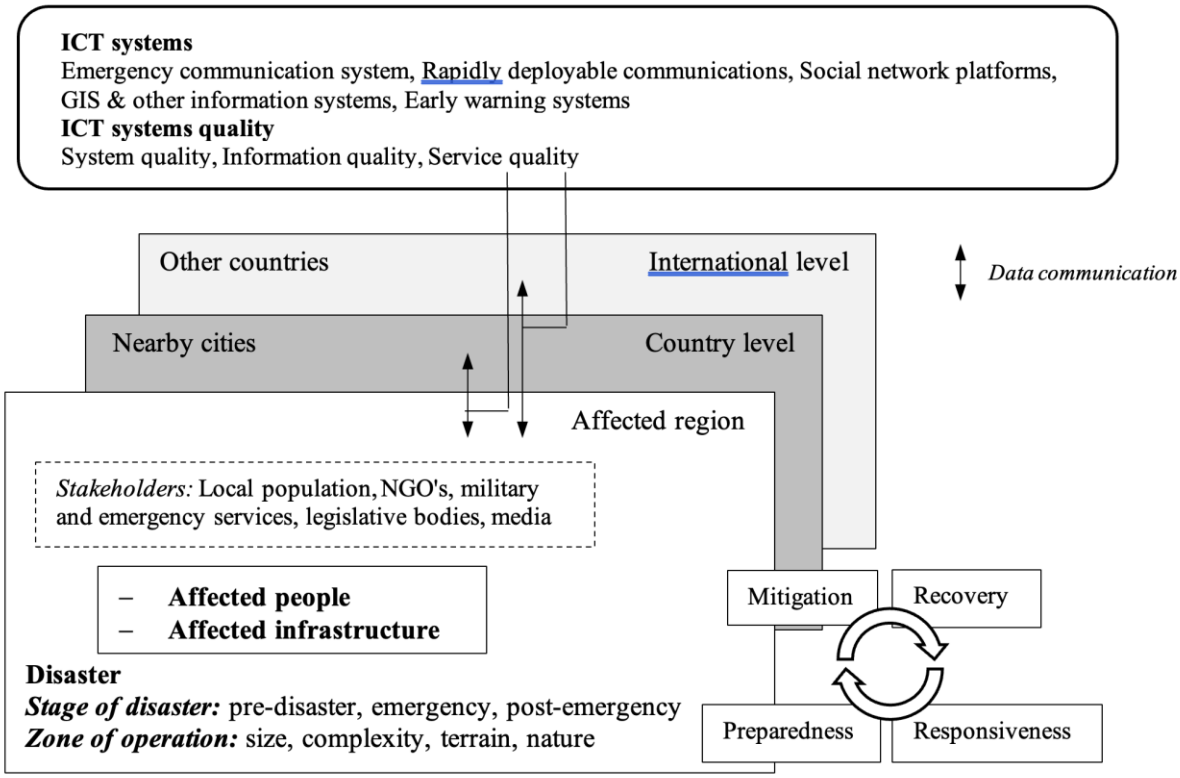

Figure 3: Conceptual framework for ICT based disaster management

Following the observations made on different ICT systems used during past-disasters, we can broadly classify them into-surveillance, decision support and broadcasting systems. The ICT based technologies such as GIS, satellite imagery form part of surveillance system proactively providing primary information about the onset of a disaster. Tsunami early warning system, Artificial intelligence tools and similar other online search/match systems form a part of a decision support system. Deployable communication systems such as radio, television, social media and other wireless/digital technology form a part of the broadcast system. Each system has unique responsibilities; however, they need to be seamlessly integrated for efficient relief operations. Each ICT enabled system links value-adding activities across a network of disaster management system through real-time information flow, thereby, enabling system-wide coordination and collaboration.

An integrated model presented in Figure 4 presents above ICT systems (surveillance, decision support and broadcasting) for quick relief operations. A dynamic concept for recovery at every possible stage of disaster management is captured in the model. It is found from the case study that relief efforts are hindered due to external challenges such as political, diplomatic, and bureaucratic issues. A cyclic process comprising of mitigation, preparedness and responsiveness are central to disaster management. The social structure of the society, its vibrancy and inclusiveness, and embedded social capital affect cyclic processes of disaster management. Similarly, nature and organisational structure of government departments and its agencies and NGOs determine the flow of resources in the relief operations and associated compliance reports. Environmental issues such as the nature of flora and fauna and environmental regulations also impact the cycles of disaster management. An integrated system adopting appropriate ICT systems during the cyclic process (mitigation, preparedness and responsiveness) of managing disasters and rapidly overcoming social, organisational and environmental issues will lead to an enhanced level of recovery.

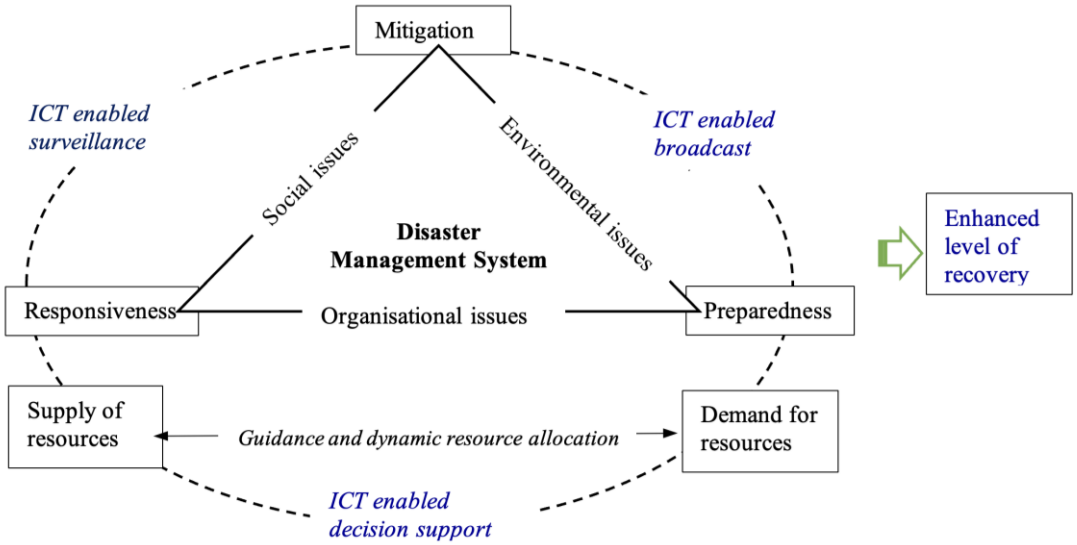

Figure 4: ICT enabled model for humanitarian relief operations

By combining holistic and structured thinking for developing an integrated model, the research provides a unique platform for ICT-enabled model for humanitarian relief operations. The challenge for humanitarian logisticians is to determine bottlenecks and the usability of communication infrastructure (Baldini et al., 2011). The developed model addresses these issues and is expected to help researchers and practitioners in closing the gap of understanding the complex interactions of ICT systems with multiple processes and external issues/challenges.

5. CONCLUSION

Discussion

The research aimed to capture the development of ICT applications in past humanitarian disasters and develop a model for humanitarian relief operations. Following a multi-case, longitudinal study, ten major natural and man-made disasters were selected for the study. A two-staged research approach followed in this paper was achieved by collating secondary data on selected cases and examining it following a systems thinking approach. Taking an ICT application and cyclic approach clue, this study proposed a conceptual framework for ICT based disaster management and developed a unique integrated model for humanitarian relief operations.

The application spectrum of ICT applications captured over the past two decades shows that GIS and online webpages/search engines are the most popular tools used for assessing the disasters. Whereas Mobile phone/SMS, social media, and satellite imaginary are also commonly seen to be used in the disaster responding. More recently, Artificial intelligence is used for data analysis and to make critical decisions. Digital technologies such as 3D printing, robots and drones are also evidently used for disaster response management. Following the longitudinal-study, it is evident that GIS, mobile network and other digital technologies (such as AI, robotics, etc.) will outperform compared to some of the traditional technologies (such as radio and land-lines) used in the past for humanitarian relief operations. It is also observed that the speed and coordination of relief operations are significantly increased in recent years due to increased use of ICT tools.

Contribution to theory and practice

The study contributes to the theory by extending the literature on humanitarian supply chains and Disaster management. ICT driven framework and model proposed in this study are derived out of systems theory-based multi-case analysis and bring a unique contribution to the theory. Proposed framework and model are highly relevant for all stakeholders involved in any disaster relief operations. The study also makes a practical contribution by providing vital insights regarding the use of multiple ICT tools for natural as well as man-made disasters. Appropriate use of such tools depending on the stage of disaster and zone of operation is expected to be useful for relief operation stakeholders. Uniquely identified and classified ICT based surveillance,

broadcast and decision support tools/systems will be helpful in future for quick relief operations. It is clear from the study that, the ICT based tools used for humanitarian disaster management have undergone rapid development over the past two decades, as information and communication technology has constantly been evolving. The need for an integrated approach for collaborative mapping and increased use of disruptive technologies is evident from the ICT enabled model. Disruptive digital technologies such as 3D printing, robotics, drones can be effectively used in extremely dangerous and remote regions for rescue and recovery. Due to the explosion of information broadcast through social media, data analytics and AI techniques are increasingly used for filtering relevant information and rapid decision making. It is expected that the key findings and models developed in this study will benefit relief organisations in understanding the challenges and appropriateness of ICT applications at different stages of disaster management.

Limitations and future avenues

The research had limitations in terms of collecting the primary data and hence widely available secondary data were utilised for the study. Selection and assessment of ten case studies were based on author's understanding of global disasters. However, generated inferences can be biased based on researchers' perception and interpretation of the event and the use of ICT tools. Also, the framework for ICT based disaster management is conceptual and not been tested in a real-world setting. Future research can look into testing both framework and model developed in this study. Since the inferences are drawn from a good mix of man-made and environmental/natural events, future studies could advance the use of ICT applications into Unmanned Aerial Vehicle (UAV), robots, online/digital donation systems and big data analytics for rapid, transparent humanitarian relief operations. It is evident from this study that ICT plays a vital role in any disaster management, and thus advanced research on ICT-based approaches for managing humanitarian disasters is commanded.

REFERENCES

Reference list is not included due to maximum page limitation and are available with the author.

SECTION 3 – SUSTAINABILITY & GLOBAL SUPPLY CHAIN MANAGEMENT

Mobility (service) innovation to increase resilience in smart sustainable cities,

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Abstract Mobility (service) innovation are important to the resilience of smart sustainable cities. The cooperative and collaborative engineering of mobility innovation is a participative process and requires joint activities of both stakeholder groups: public and private. While citizens are encouraged to pro-actively report data and announce their needs, government and decision makers are encouraged to transform the data and reported needs into service requirements. Currently, both groups lack a participation system to collaboratively create innovation and to cooperatively develop the Mobility of the Future. Within this scholarly article, we not only analyze the citizens' requirements but also evaluate their need towards innovation and resilience in smart sustainable cities. We propose a data collector and data visualizer app to co-create joint mobility innovation and increase system resilience. This app acts as interface between mobility stakeholder groups and enables participative mobility innovation and resilience engineering.

Keywords: • Mobility of the Future • Innovation & Resilience • Sustainability • Melinda •

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1 Introduction

Mobility is fundamental to society and is an essential contributor to economic prosperity: it is a job engine and employs millions of people. At the other side of the coin, mobility is one of the core drivers of the climate change and thus causes tremendous negative costs. Citizens suffocate from increased (individual) traffic and whole regions become prone to smog. To avoid such 'climate emergencies', many cities and regions started to actively act on the smart city challenge: the objective to design, develop and engineer cheaper, faster, safer, greener, more efficient and more convenient mobility of citizens, as announced by the U.S. Department of Transportation (U.S. DOT) [1]. The research into and the innovation of the mobility of the future, as highlighted by the European Commission (EC) [2], is an important priority in smart sustainable city developments. Innovation shall lead to the "revolution" of transportation systems [1] and the emergence of new transport patterns [3].

This scholarly article at hand investigates into the paradigm of the 'Future of Mobility' (FoM). It addresses the challenge of emergent individual mobility needs within smart sustainable cities. Individual mobility needs, as highlighted by Deloitte [4] are idiosyncratic and almost impossible to manage. To cope with this long and bumpy [5] challenge, this article addresses participative innovation engineering among mobility stakeholders: public and private. The guiding research question of this article is "**how mobility stakeholders can foster the co-creation of the Mobility of the Future: the collaborative launch innovation and the cooperative increase of system resilience**". This article is driven by the motivation by the development of a mobility participation system that establishes co-creation mechanisms among stakeholders to launch innovation and to increase resilience of smart sustainable cities. In the center of this research endeavor is the development of a mobility data collector and mobility data visualizer

mobile app that enables co-creation mechanisms between stakeholders: processes that stimulates and boost processes of innovation within and the design and development of enhanced levels of resilience of smart sustainable cities.

The contextual embedment of this article at hand is on innovation and resilience. Innovation is an intense discussed notion in theory and practice. Within this article, we consider Schumpeter's approach as theoretical underpinning to innovation. Centre to Schumpeter is the dynamic entrepreneur that creatively deconstruct and innovate. In doing so, this dynamic entrepreneur continuously innovates products, services and processes, develops sources and supplies of raw material, semi-finished products and new market sales, implements a new organization/organizational culture/restructuring of an organization and industry, break through monopolies (and creates a monopoly). The dynamic entrepreneur forces profound social change – processes of creative destruction. However, the notion of resilience is especially discussed in literature. From this theoretically perspective, the notion of resilience denotes the ability of a system not only to cope with crisis situation but also to emerge from to a better competitive position after the event. Due to the fact that theory is highly determine by controversy definitions, within this article, we will make use of the Strategic Management Framework for Engineering of Organizational Robustness and Resilience [6]. This framework guides to design and engineer VRIN resources, organizational-, responsiveness-, cognitive- and dynamic capabilities at the resource-, operational-, tactical- and strategic business level of a system towards increased levels of organizational robustness and resilience.

Based on Design Science Research [7], this article at hand presents the findings achieved in the relevance cycle: investigation into citizens (individual) mobility needs and requirements as basis for the development of system requirements for the mobility data collector and mobility data visualizer app. It bases on empirical research – *stakeholder interviews with citizens at several farmer markets* – about the Future of Mobility within the region of Vorarlberg and its neighboring regions.

This article is structured among four chapters. While chapter one is about the introduction and presentation of the research question and motivation, chapter two introduces applied research design. Chapter two presents fundamental statistics about selected sample size: citizens within the region of Vorarlberg (*and beyond*). Additionally, we compare some key results with a study, conducted by the European Union in 2010 with our study within the region of Vorarlberg. Chapter three qualitatively presents the results of investigated topics: mobility activities and preferences of selected sample size, it approach towards public transportation and its approach towards mobility participation.

2 Research design, demographics and relevance

This article at hands is methodologically manifested in Design Science Research and builds up on the Information Systems Research Framework (ISRF) [7].

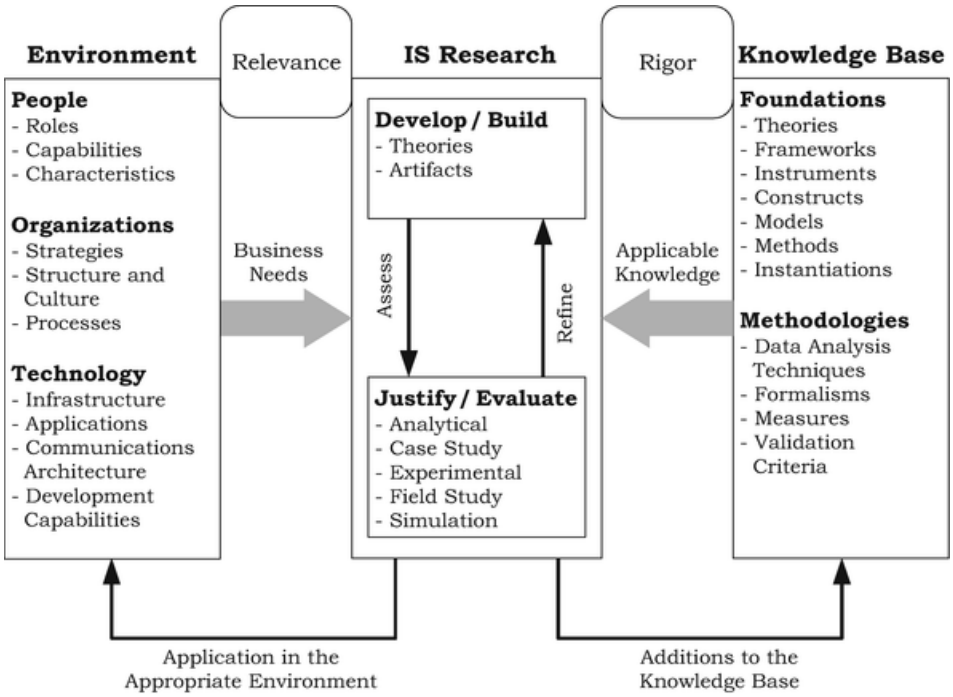

Figure 1: Information System Research Framework (ISFR) [7]

As depicted in figure 1, the ISRF captures three main pillars that are the relevance cycle, rigour cycle and design cycles [8], [9]. The relevance cycle focuses on the system's environment – mobility stakeholders, as defined in this article – and aims to analyze and evaluate the system stakeholder's needs towards set research question. The rigour cycle focuses on the (already existing) knowledge base. It investigates into the knowledge and expertise of selected field of research and is about the analysis and evaluation of literature and media towards set research question. The design, development and (re-) engineering of intended artefact is part of the design cycle. This cycle capitalizes the knowledge gained in the relevance cycle and the rigour cycle.

In contrast to many research projects within Information Systems, within this article we do not have to start from the scratch: a preliminary version of intended mobility data collector and data visualizer app already exists and is the backbone of our a) interview sessions and b) the app development. However, within this article at hand, we focus on the relevance cycle and investigates into how mobility stakeholders can foster mobility innovation and resilience as well as to speed up the adoption of mobility innovation in smart sustainable cities. In doing so – namely the analysis and evaluation of the "citizen's needs" (of individual mobility) – this research makes use of a tailored survey method: stakeholder interviews among a pre-defined questionnaire. Applied questionnaire consists of 16 open and closed questions. In preparation of the questionnaire, we followed the approach of Denz [10]. The first questions of the questionnaire aimed to investigate into the demographics or particular interviewee and to increase their interested about the FoM. Afterwards questions about (smart) mobility, (smart) mobility behavior and tracking of mobility by a targeted mobile app (the artefact to be developed in the design cycle) were asked. The questionnaire concluded with a simple gamification questions (yes/no-questions) about the average costs of a car per month, particulate matter and sports/physical activities.

The survey started on the 9th of July 2019 by the conduction of "test interviews" in and around the facilities of the Vorarlberg University of Applied Sciences. Based on gained feedbacks, the questionnaire experienced a slight modification and adaption of some questions for the research

in empirical field. Taken together, 155 citizen interviews at eleven farmer markets in selected towns and villages within the region of Vorarlberg (Dornbirn (3 times), Bregenz (2), Feldkirch, Hohenems, Bludenz, Lustenau, Götzis and Feldkirch (1 time each)) and the town of Lindau (Bavaria, Germany) have been conducted. Additionally, we participated at the Vorarlberg Bahn-Bus Mobil Tag (a specialized event about passenger mobility organized on the 16th of July 2019). Furthermore, we capitalized situational circumstances, such as our own arrival and departure by public transportation to and from an event as well as at crowed places within the Federal State of Vorarlberg (e.g. at the harbor of Bregenz)).

During the interviews (in the empirical field), the responses were documented in a pre-defined template (hardcopy; physical documentation). Later (in the office), the interviews got transcribed and digitalized (in an Excel file). The Excel file is basis for structured analysis and evaluation by the use of Microsoft Excel, R-Studio and SQL.

2.1 Demographics, transport modes in use and relevance

In total, 155 citizens participated within the survey. 119 (out of the sample size) have their main residence in Vorarlberg, 9 in Bavaria, 8 in Baden-Wurttemberg, two in Tyrol and one in St. Gallen. 16 interviewees are not from these areas or did not contribute to this question. The youngest interviewee of our survey is born in 2005 whereas the oldest interviewee is born in 1932. The average age of the interviewees is 49 years. During the survey phase, we experienced a broad consensus of our interviews: only ten (out of 155) interviewees showed a negative attitude towards our research and only one interviewee aborted the interview/questionnaire prematurely. The ratio of female interviewees compared to the total interviewees is 62:38. The ratio of female interviewees compared to the total interviews with main residence in Vorarlberg is 67:33.

As depicted in figure 2, one third of interviewees responded that their "favorite transport mode" is the bicycle (33,55 %), followed by car (29,03 %) and train (14,84 %). However, asked about the "mainly used transport mode", one third of the interviewees responded that the car (34,19 %) is the mainly used means of transport, followed by bicycle (25,81 %), bus (16,13 %) and train (13,55 %).

	Total				Main residence							
					Vorarlberg				Others			
Mean of transport	Favorite	Rel	male	female	Abs	Rel	male	female	Abs	Rel	male	female
Bicycle	52	33,55%	16	36	38	31,93%	9	29	14	38,89%	7	6
E-Bike	7	4,52%	1	6	7	5,88%	1	6				
Car	45	29,03%	22	23	33	27,73%	14	19	12	33,33%	8	4
E-Car												
Motorbike	7	4,52%	2	5	5	4,20%	2	3	2	5,56%	2	
Bus	13	8,39%	5	8	12	10,08%	5	7	1	2,78%	1	1
Train	23	14,84%	9	14	20	16,81%	8	12	3	8,33%	1	2
On foot	7	4,52%	1	6	4	3,36%		4	3	8,33%	1	2
Others (Boat)	1	0,65%	1						1	2,78%	1	
Abortion												
Total	155	100%	57	98	119	100%	39	80	36	100%	21	15

	Total				Main residence							
					Vorarlberg				Others			
Mainly used	Rel	male	female	Abs	Rel	male	female	Abs	Rel	male	female
39	25,16%	13	26	32	26,89%	9	23	7	19,44%	4	2
5	3,23%	1	4	4	3,36%	1	3	1	2,78%		1
53	34,19%	26	27	37	31,09%	14	23	16	44,44%	12	4
1	0,65%		1	1	0,84%		1				
6	3,87%	3	3	5	4,20%	2	3	1	2,78%	1	
25	16,13%	6	19	21	17,65%	5	16	4	11,11%	1	3
21	13,55%	10	11	17	14,29%	8	9	4	11,11%	2	2
3	1,94%		3	2	1,68%		2	1	2,78%		1
1	0,65%	1						1	2,78%	1	
1	0,65%		1					1	2,78%		1
155	100%	60	95	119	100%	39	80	36	100%	21	14

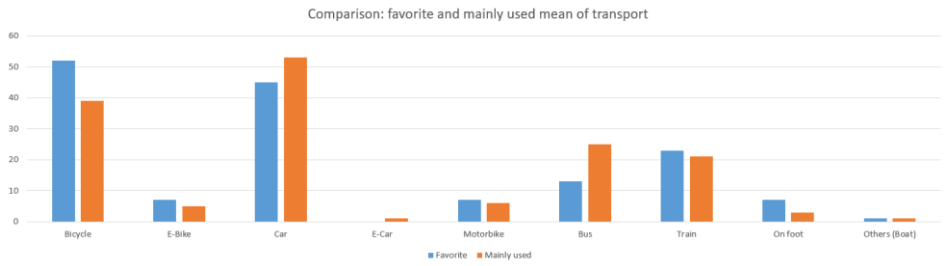

Figure 2: Comparison – favorite and mainly used mean of transport

Related to the question, which transport modes are mainly used over the day, we identified transport modes "car" and "bicycle" as the most used means of transport. Taken together, they account for more than a half (car: 26,51%, bicycle: 25,60%; responses: 154).

2.2 Relevance

As we identified in our literature review, the research on transport mobility preferences already experienced important relevance for government and decision makers. For example, the European Commission, tasked by the department DG Transport & Mobility, ask similar question(s) in 2011. While the Commission's interest was on the "main mode of transport" [11], our interest is more holistic and integrates, as depicted in figure 2 and chapter 3, the "favorite transport mode" and related activities and preferences.

The comparison between the research results of these studies shows that the citizens in Vorarlberg heavily changed attitude towards sustainable means of transport from 2011 until 2019. As depicted in figure 3, cluster "Car & motorbike" decreased interest in the past nine years whereas cluster "public transport" and cluster "walking & cycling" gained attraction.

	Empirical research in the greater region of Vorarlberg (2019)						Analytical Report: Future of transport (2011)					
	Total		Vorarlberg		Others		European Union*		Austria*		Vorarlberg**	
Means of transport	Abs	Rel	Abs	Year 2019	Abs	Rel	Abs	Rel	Abs	Rel	Abs	Year 2011
Car & motorbike (incl. E-Car)	60	30,88%	43	29,51%	17	47,22%	14064	55,00%	622	62,00%	27	62,00%
Public Transport (bus & train)	46	24,26%	38	25,41%	8	22,22%	5625	22,00%	201	20,00%	9	20,00%
Walking & Cycling (incl. E-Bike)	48	44,12%	38	45,08%	10	27,78%	5114	20,00%	160	16,00%	7	16,00%
Other (*or no daily/regular mobility*)	1	0,74%			1	2,78%	767	3,00%	20	2,00%	1	2,00%
Total	155	100,00%	119	100,00%	36	100,00%	25570	100,00%	1003	100,00%	44	100,00%

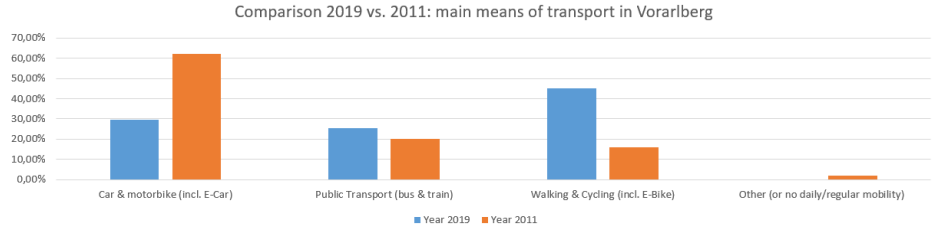

Figure 3: Comparison 2019 vs. 2011: main means of transport in Vorarlberg[1]

Exact reasons for the shift towards "soft mobility" are not known but it is highly to assume that governmental investments into mobility infrastructure (further development of public transport [13]), the provision of affordable tickets for public transport (e.g. a ticket for public transportation within the region of Vorarlberg for 365 EUR/year [14]; affordable mobility for all [15]) and the trend of e-mobility (that has captured the stakeholders of Vorarlberg in the past few years [16]) play a major role.

3 Interview analysis and findings

This chapter is about the analysis and evaluation of the conducted interviews and is organized among three sections. Section one presents the activities and preferences of interviewed citizens in combination with the used transport mode. Section two presents the interviewed stakeholders' preferences towards transport modes. Section three presents the stakeholders' perception towards intended basis functionalities of intended data collector and data visualizer mobile app as stakeholder system for participative mobility innovation.

3.1 Analysis: activities and preferences

The analysis about the mobility activities and preferences supports to understand the status quo about citizen's individual mobility. The response option to this question was open and interviewees were encouraged to freely report their activities and preferences. In applied analysis scheme, collected answers experienced an in-depth clustering process and finally are categorized into 5 categories: everyday life, leisure time, work, shopping and other. As depicted

[1] *based on analytical report „Future of transport" of the European Commission, DG Transport & Mobility [11] (1003 respondents in Austria); **based on Statistik Austria [12]: computation of the statistical normal distribution: 8.401.940 citizens in Austria, 370.440 citizens in Vorarlberg, ratio: 4.41%

in figure 4, we put minor emphasis on the transport mode "e-car" since it only has a response rate of 0,65%. One interviewee responded to this transport mode and specified that he uses the e-car for shopping and other (long distances).

	On Foot		Bicycle		E-Bike		Car		E-Car		Bus		Train		Motorbike	
Activity	Abs	On Foot	Abs	Bicycle	Abs	E-Bike	Abs	Car	Abs	E-Car	Abs	Bus	Abs	Train	Abs	Motorbike
Everyday life	84,86	77,85%	27,33	48,80%	9	39,13%	11,2	18,36%			24	42,86%	21	36,21%	2,34	14,63%
Leisure time	14,15	12,98%	14,66	26,18%	8,83	38,39%	4	6,56%			12,5	22,32%	13	22,41%	7	43,75%
Work	4,66	4,28%	5,83	10,41%	1	4,35%	27,87	45,69%			9,5	16,96%	13	22,41%	4	25,00%
Shopping	3,5	3,21%	3,68	6,57%	2,67	11,61%	12,03	19,72%	0,5	50,00%	2	3,57%	1,5	2,59%		
Other	1,33	1,22%	2,5	4,46%	1,5	6,52%	5,9	9,67%	0,5	50,00%	2,5	4,46%	3	5,17%	2,33	14,56%
Everything	0,5	0,46%	2	3,57%											0,33	2,06%
Sometimes											5,5	9,82%	6,5	11,21%		
Total	109	100%	56	100%	23	100%	61	100%	1	100%	56	100%	58	100%	16	100%
Responding interviewees	147		108		23		104		1		105		113		16	
Return rate (out of 155 resp. 154)	94,84%	95,45%	69,68%	70,13%	14,84%	14,94%	67,10%	67,53%	0,65%	0,65%	67,74%	68,18%	72,90%	73,38%	10,32%	10,39%

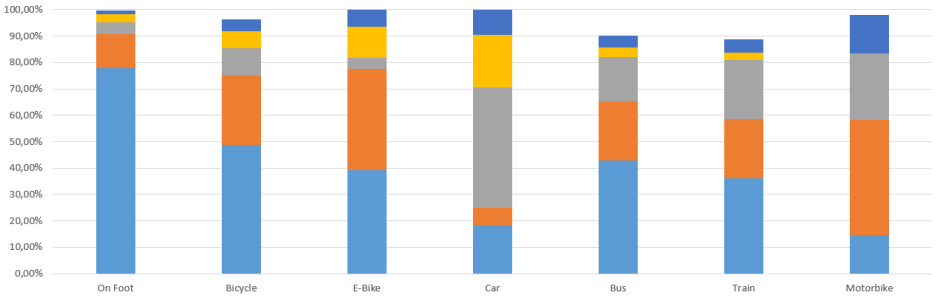

Figure 4: Used transport modes for the activities

As depicted in figure 5, transport mode "on foot" is the main determinant within the interviewees' everyday life. Transport mode "car" is mainly used for work, as 45,69 % of the interviewees said. In the interviewees' leisure time, the transport modes "on foot, bicycle, e-bike, public transport (bus & train) and motorbike" have a dominant role. Although 35,37% already use transport mode "public transportation" (bus, train; on regular basis), 64,63% stated the opposite.

	On Foot		Bicycle		E-Bike		Car		E-Car		Bus		Train		Motorbike	
Activity	Abs	On Foot	Abs	Bicycle	Abs	E-Bike	Abs	Car	Abs	E-Car	Abs	Bus	Abs	Train	Abs	Motorbike
Everyday life	84,86	77,85%	27,33	48,80%	9	39,13%	11,2	18,36%			24	42,86%	21	36,21%	2,34	14,63%
Leisure time	14,15	12,98%	14,66	26,18%	8,83	38,39%	4	6,56%			12,5	22,32%	13	22,41%	7	43,75%
Work	4,66	4,28%	5,83	10,41%	1	4,35%	27,87	45,69%			9,5	16,96%	13	22,41%	4	25,00%
Shopping	3,5	3,21%	3,68	6,57%	2,67	11,61%	12,03	19,72%	0,5	50,00%	2	3,57%	1,5	2,59%		
Other	1,33	1,22%	2,5	4,46%	1,5	6,52%	5,9	9,67%	0,5	50,00%	2,5	4,46%	3	5,17%	2,33	14,56%
Everything	0,5	0,46%	2	3,57%											0,33	2,06%
Sometimes											5,5	9,82%	6,5	11,21%		
Total	109	100%	56	100%	23	100%	61	100%	1	100%	56	100%	58	100%	16	100%
Responding interviewees	147		108		23		104		1		105		113		16	
Return rate (out of 155 resp. 154)	94,84%	95,45%	69,68%	70,13%	14,84%	14,94%	67,10%	67,53%	0,65%	0,65%	67,74%	68,18%	72,90%	73,38%	10,32%	10,39%

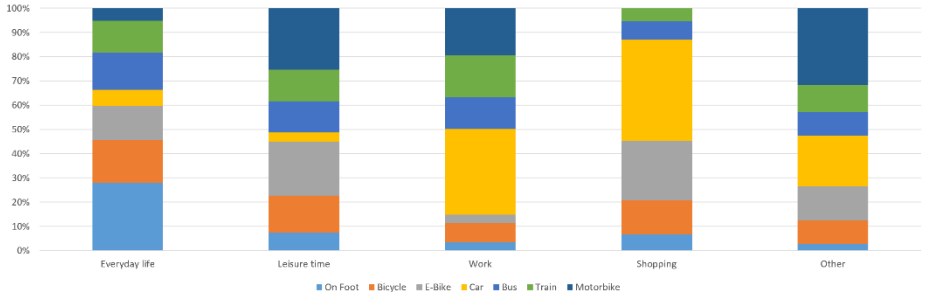

Figure 5: Activities of interviewees by using different transport modes

By use of the same data but interpreted with activities, the result highlights an intensive use of transport mode "car" within the activities "work", "shopping" and "others". But also, the result shows the minor role of the car in activities "everyday life" and "leisure time". Within these activities, sustainable transport modes are dominant.

To analyze what is important in the interviewees' daily routes, we asked about six pre-defined categories that are: health & sport, environmental compatibility and minimization of pollutants, efficiency & speed, cost efficiency, high availability and sociality (entertainment). The interviewees (total: 154; 96 female, 58 male) reported their individual importance on a Likert

scale, ranging from 1 – 6 (*where 1 means 'does not apply' and 6 'correct'*). As depicted in figure 6, the high availability of transport modes is of major importance (5,47 out of 6) to the interviewees. Following categories are environmental compatibility and minimization of pollutants (5,06/6), health & sport (4,73/6), efficiency & speed (4,34/6) and cost efficiency (4,60/6). The less important category is sociality (entertainment) and gained 3,24 points out of 6.

			What is important in your daily routes?											
	Interviewees		Health & sport		Environmental compatibility and minimization of pollutants		Efficiency & speed		Cost efficiency		High availability		High society	
Main residence	Male	Female	M	F	M	F	M	F	M	F	M	F	M	F
Average (without gender)	154		4,73		5,06		4,34		4,60		5,47		3,24	
Average (without residence)	58	96	4,78	4,70	4,81	5,22	4,38	4,31	4,67	4,55	5,17	5,66	3,50	3,08
Baden-Württemberg	6	2	3,83	4,00	3,83	6,00	4,67	4,00	4,83	4,50	5,67	5,00	3,17	3,50
Bavaria	6	2	5,00	5,50	4,67	6,00	3,83	5,00	5,33	4,00	5,67	4,50	2,33	2,00
St. Gallen	1		6,00		1,00		6,00		6,00		6,00		1,00	
Tyrol		2		5,50		5,50		5,50		5,50		5,50		3,50
Vorarlberg	39	80	4,69	4,64	4,90	5,15	4,54	4,29	4,67	4,60	4,87	5,69	3,92	3,19
Other	6	10	5,83	5,00	6,00	5,40	3,33	4,20	3,67	4,10		5,80	2,67	2,30

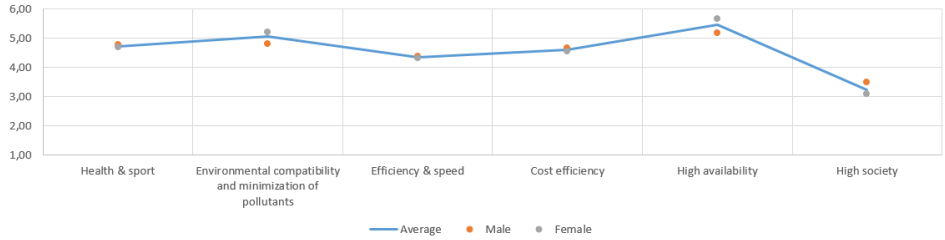

Figure 6: What is important in your daily routes?

Differences among gender can be found in categories environmental compatibility and minimization of pollutants, high availability and sociality (entertainment). Environmental compatibility and minimization of pollutants and high availability of transport modes are more important to female, whereas sociality (entertainment) of transport modes is more important to male.

3.2 Analysis: public transport

Section 2 presents the interviewees' preferences towards sustainable modes of transport: public transport including train and bus. Based upon applied clustering process (*to present heterogenous responses in a clearly arranged format*), interviewees' responses can be grouped into seven categories (2a) connections, infrastructure, home place/residence, (2b) transport (e.g. of goods), (2c) convenience, comfort, simply to use, laziness, (2d) time, speed, flexibility, availability, mobility, (2e) long distances, complicate, change mode, capacity utilization, connections, (2f) other (e.g. weather, disability, expensive, meetings, additional ways, etc.) and (2g) work. As depicted in figure 5, the most important reasons not using public transport are missing connections, infrastructure and (because of the) home place (19,03%), followed by transport (e.g. of goods, etc.; 17,19%), convenience, comfort, simply to use, laziness and other reasons (each 14,65%).

Pos.	Abs	Comparison Pos. 1, 2 & 3		
1 Already in use	52	33,55%	35,37%	
2 Reasons not to use public transport	95			
2a Connections, infrastructure, home place	18,08	11,66%	12,30%	19,03%
2b Transport (e.g. of goods, etc.)	16,33	10,54%	11,11%	17,19%
2c Convenience, comfort, simply to use, laziness	13,92	8,98%	9,47%	14,65%
2d Time, speed, flexibility, availability, mobility	12,25	7,90%	8,33%	12,89%
2e Long distances, complicate, change mode, capacity utilization, connections	11,67	7,53%	7,94%	12,28%
2f Other, e.g. weather, disability, expensive, meetings, additonal ways, etc.	13,92	8,98%	9,47%	14,65%
2g Work	8,83	5,70%	6,01%	9,29%
3 N/A	8	5,16%		
Total (incl. Pos. 1, 2 & 3)	155	100%		
Total (incl. Pos. 1 & 2)	147		100,00%	
Total (incl. Pos. 2)	95			100,00%

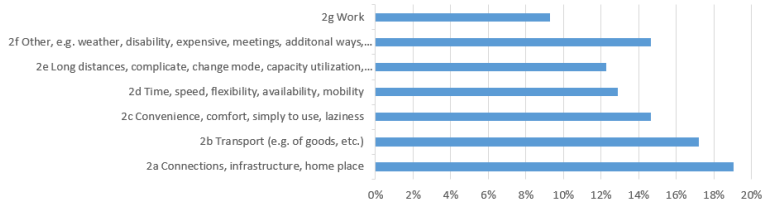

Figure 7: Reasons not to use public transport

The majority of the interviewees expressed their confirmation towards more use of public transport services in future. 116 interviewees are positive towards the use of public transport services in future (*evaluation on a Likert scale ranging from 1 – 6 (weak – strong confirmation)*). However, 22,15% of the interviewees are reserved towards public transport. ~82% out of these 22,15% expressed weak confirmation towards the use of public transport services in future. Reasons not to use public transport services are still, for example, work (place), location (rural areas), missing connections and offers as well as comfort and laziness.

3.3 Analysis: mobility participation – app design and development

Section 3 investigates into the interviewees' preferences related to intended data collector and data info visualizer app to co-create mobility service innovation. As guiding framework to coordinate the citizens' preferences towards intended mobility data collector and data visualizer app, we used the ISO 9126 – software engineering – product quality, part 2: external metrics. Based on the framework, we confronted the interviewees with a sample of software/app characteristics that are about efficiency[2], reliability[3], usability[4] and functionality[5].

Related to the characteristic "**efficiency**", interviewees highlighted that simplicity of intended app is of highest priority. On a Likert scale, ranging from 1-6 (*1 determines the lowest and 6 the highest confirmation*), simplicity gained 5,71 points. This is the top value of all the following characteristics. Related to characteristic "**reliability**", stakeholders highlighted the importance of trust, anonymity and freedom of advertising. Trust gained 5,69 points, followed by freedom of advertising (5,46) and anonymity (5,39). Related to characteristic "**usability**", interviewees highlighted that the value added for the user is not necessarily "a must". It gained 4,50 points. A feedback function within the app is rated with 4,20 points. The characteristic "**functionality**" is, according to the existing prototype of the data collector and data info visualizer app, divided into planning of routes, analysis of routes and statistics & monitoring. Compared among each other, statistics & monitoring gained most interest. It gained 4,47 points (Likert scale). The analysis of routes and planning of routes gained 4,28 resp. 3,94 points.

[2] capability of the software product to provide desired performance, relative to the amount of resources used, under stated conditions
[3] capability of the software product to maintain its level of performance under stated conditions for a stated period of time
[4] capability of the software product to be understood, learned, used and provide visual appeal, under specified conditions of usage
[5] capability of the software to provide functions which meet the stated and implied needs of users under specified conditions of usage

- **Statistics & monitoring**: we asked interviewees about the sub-characteristics of travelled kilometers, used time, CO2 emission and savings as well as calorie consumption. On this occasion, travelled kilometers seems to be the most important characteristic for statistics & analysis. This sub-characteristic gained 4,90 points (Likert scale), followed used time, CO2 savings, CO2 emission, calorie consumption.
- **Routes**: this section is composed of four sub-characteristics. According to the interviewees' responses, the display of route specific points (from/to) in the app is of most interest of the interviewees. On a Likert scale, ranging from 1-6 (where 1 means the lowest level and 6 the highest level), this characteristic gained 4,75 points (of six possible), followed by display of transport modes (4,64), graphical visualization (4,45) and statements for reasons of the route (3,29).
- **Planning of routes**: In general, a route planning function is of major interest of the interviewees. It gained 4,79 points (Likert scale), followed by display of transport modes (4,19), graphical visualization (3,76) and statements for reasons of the route (3,02).

4 Refinement of the data collector and data visualizer app

Based on the data captured within the empirical research as well as the findings within its analysis and evaluation, we elaborated a requirement engineering report. This report supported us to focus on the identified needs and requirements of the interviewees and to implement the functionalities into the existing data collector and data visualizer app (c.f. figure X). Measures into the app are about efficiency, reliability, usability and functionality to attract the app and increase the app user participation. We worked on visible and invisible measures – measures that have direct and indirect impact to the app user, as presented in the following sections about the app's efficiency, reliability, usability and functions.

4.1 Efficiency

We migrated the app server to a scalable server. This is an important efficiency measure, since this migration enable us to increase and decrease the computation capacity due to the user's demands and needs. To not to bother the app user with untargeted questions, we decided to reduce the registration dashboard up to three simple questions: registration e-mail, year of birth, location (on country level). To all to the other settings (e.g. preferences, target values, etc.), the user can respond to it in the profile section voluntarily.

4.2. Reliability

To enhance the trust and anonymity between the app users and us (as analysts and evaluators of the data), we reworked, adapted and modified the GDPR section towards the app user's advantages. For example, the app captures two dynamically configured sections for GDPR and the imprint. Within these sections, the app users get informed about his/her voluntary participation within the app and the handling and forwarding of data for analysis and evaluation: no data will be forward until the app user explicitly agrees on it. If the app user forwards data (on travelled distances), the data will be anonymized. Due to some requests (coming from befriended organizations within the design and development of the app), we decided to not to include advertisements and to keep the app free of it.

4.3 Usability

To increase to usability of the app, we decided to rework the app's interfaces and to include Rome2Rio. The user now is entitled to seamlessly plan its routes globally. Additionally, a feedback function is integrated into the app. By clicking on a hyperlinked "contact"-button, the app user can report positive and negative feedbacks to us (as the developers of the app). This increases

4.4 Functionality

Due to the knowledge gained within the survey, we extended the app functionality and developed a tool to control the app users individual statistics and its monitoring. As depicted in figure XXX, we integrated new algorithms to compute the CO2 emission and calorie consumption based on the chosen transport mode and the time consumed. Additionally, based on the app users profile preferences, we included a mobility award game: based on the app user's profile, he/she can gain and collect "smileys". As depicted in figure xxx, a laughing smiley, for example, denotes that the app user met the his/her goal; a neutral smiley denotes that the app user did not reach any goal; a crying smiley denotes that the app user runs behind his/her goals. This function is available on daily-, weekly-, monthly- and yearly basis and shall motivate the user to a) track his/her mobility and release his/her mobility patterns (for the analysis through external experts), b) to monitor its pollution (caused by his/her mobility) and to c) control and monitor its fitness values (calorie consumption, kilometers travelled)per bike, on foot, etc.

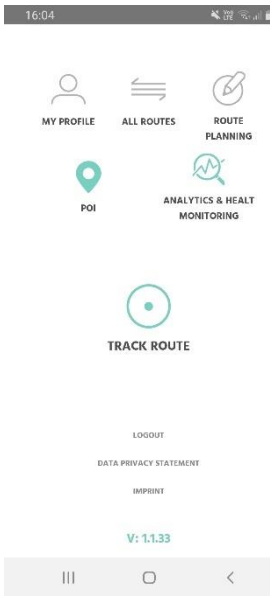

Figure 8: Dashboard

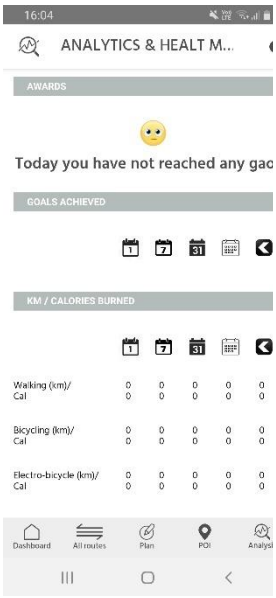

Figure 9: Awarding

Figure 10: Point of interest

Additionally, we integrated a section for important point of interests for smart mobility and mobility services as well as the navigation (from the present position) to the chosen point of interest.

4 Discussion and conclusion

In this article, we analyze the status quo in individual mobility in the region of Vorarlberg. We put major emphasis on the individual mobility behaviors since these are the heart of the smart sustainable city evolution [17]. Based on this analysis, we further developed a data collector and data visualizer app for the development of smart mobility innovation. As a "small" partial success, after the individual interviews and presenting the App, 63,23 % agreed or showed the willingness to track their mobility and mobility patterns with the data collector and data visualizer app (before: 64,29 % said no).

Related to initial research question about "**how mobility stakeholders can foster the co-creation of the Mobility of the Future: the collaborative launch innovation and the**

cooperative increase of system resilience", we are convinced that information- and app technology is critical enabler for smart sustainable city solution. Nevertheless, as identified, interviewed stakeholders neither make much use of technology nor share information about their mobility. Smart sustainable cities are depended on active stakeholder participation: citizens are encouraged to be open to permit new technologies and services [17] in their daily life. These data are of major importance for mobility planners: to know the empirical basis, its behaviors, activities, preferences, enablers and disablers.

In design and development of intended data collector and data visualizer app, important to citizens are statistics & monitoring (e.g. travelled kilometers), analysis of routes (e.g. route-specific points) and planning of routes (e.g. route planning function). But as detected too, the characteristics as well as assigned sub-characteristics have potential for improvement. To increase participative innovation, from this research we learned that intended data collector and data visualizer app requires not only mobility innovator advantages (e.g. data analytics, traffic flow analysis, etc.). The app needs to provide incentivize functionalities for users. Our next step is to design, develop and engineer such user incentives, e.g. award system, mobility goals and statistics, etc.

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ALIGNING GREEN SUPPLY CHAIN MANAGMENT WITH PRODUCT TYPES

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Purpose of this paper:
This study aims to explore *how* green supply chain management (GSCM) practices can be implemented more efficiently and effectively in the rapidly changing market. We attempt to identify dynamic transformation across a company's internal and external green supply chain operations with green product development on different product markets.

Methodology:
This study adopts an exploratory case study, investigated one of the largest multinational ICT companies, an early adopter of GSCM in China that leads the domestic consumer electronics market environmental reform. We examined company's GSCM transformation across its four key product lines. Eleven in-depth interviews were conducted with numerous onsite visits, online meetings and follow-up phone calls for qualitative data collection. We applied thematic coding analysis with Nvivo software followed by a thorough within-case and cross-case comparison analysis.

Findings:
The findings of this study propose a strategic taxonomy of GSCM on different products. For generic products, improving volume efficiency and reducing wastage on internal operations and supply chain cost is the priority for GSCM. Among them, durable generic products can improve use life efficiency through building long-term customer relationships and service flexibility while extend (green) product life. For fast-consuming generic products, business can improve close-loop resource efficiency via expansion of operations to include internal volume recycling.

For premium niche products, improving eco-design and building dynamic relationships with supply chain stakeholders for value creation is the key for GSCM. Among them, fast fashionable niche products can improve existing value via adapting product design and enhancing process integration and total system responsiveness for underexploited market expansion, e.g., second-hand market. For durable premium products, business can create green value via radically product design innovation and system upgrade for new market development. Key operational and relationship capability elements are further identified for each strategy in findings.

Value:
The study contributes to knowledge of GSCM and competitive strategies. It enriches the GSCM literature by specifying the linkage between various product supply chains and green approaches, in terms of internal operations, external operations and eco-design management.

INTRODUCTION

Environmental sustainability has become an essential initiative of firms to create value and gain competitive advantage rather than a voluntary obligation that might contradict the traditional corporate economy objectives (Seuring and Muller, 2008; Graham, 2018). There have been many studies focusing on identifying "what" green supply chain management (GSCM) practices businesses should implement and "what" impacts these practices can have on company performance (Graham and Potter, 2015). Nevertheless, "how" companies can implement green initiatives efficiently and effectively in their supply chains is not well understood (Lee et al., 2015).

Researchers (Brindley and Oxborrow, 2014; Kumar and Rodrigues, 2017) have proposed a number of diverse competitive GSCM strategies for businesses to implement based on their product-market positions and supply chain characteristics. To meet demand from a less green sensitive market, GSCM could leverage on standardisation and resource efficiency to comply with environmental requirements while reducing internal cost. On the other hand, to meet demand from a highly sensitive green market, GSCM could focus on innovative green product development and new market expansion (Zhu et al., 2020). Underpinning such GSCM strategies are traditional principles of supply chain management to aligning downstream market needs with upstream supplies.

With contemporary GSCM concept incorporating close loop management, eco-product design and total system lifecycle management, it is unclear *how* GSCM strategies can effectively cope with new operational and supply chain relationship dynamics. With rapid development in technology, strong consumers' desire for the latest products with short product lifecycle, as well as increased wastages associated with production and packaging, manufacturers are confronted with ever increasing challenges to integrate green into their supply chains (Reche et al., 2020). To understand the strategic dynamics between a company's internal and external supply chain operations with product development, this study conducts an exploratory in-depth case study with one of the early GSCM adopters in China.

THEORETICAL BACKGROUND

Competitive strategies of GSCM

GSCM is defined as integrating sustainable Environmental Management (EM) measures into business supply chain (Srivastava, 2007). This can include processes such as product design, material sourcing and selection, manufacturing and production, operation and end-of-life management (Sarkis, 2012). When integrating green concepts at corporate level, strategic resources can be invested in building green processes and developing product capabilities to create new business competitive advantage (Seuring and Muller, 2008). Extant literature shows that competitive value is driven via two general ways of green integration: i) lean and efficient greening for internal compliances and reducing supply chain costs (Corbett and Klassen, 2006; Kurdve et al., 2014; Piercy and Rich, 2015) and ii) product stewardship and differentiation for green demand and value creation (Ginsberg and Paul, 2004; Sharma and Iyer, 2012).

Although some may argue that lean is not a cost reduction but a value-adding strategy, we apply the term in this study referring to the use of only the absolutely necessary resources to produce and package products so as to reduce waste and hence cost. Standardisation design is often employed for mass production (Fisher, 1997). A lean and efficient green strategy can be adopted when market demand is predictable while supply is stable. In such case, a generic supply chain suffices. This involves the consolidation of the supply base with accredited wholesale suppliers who are able to meet the sustainability objectives through their Environmental Management Systems (EMS) (Brindley and Oxborrow, 2013). This can involve integration of local distribution centres, small but regular deliveries, management of packaging, and product selection from an array of upstream suppliers etc. By leveraging on supply-driven supply chain operations, the objective is to comply with external regulations, standards, and to achieve a measurable reduction of pollution and wastes on supply chain (Bowen et al., 2001; Hart and Milstein, 2003).

A value-creating green strategy can be adopted when market demand is unpredictable while supply is unstable. Under such circumstances, an agile or risk-hedging supply chain is appropriate (Lee, 2002). This involves regular exchange of information to reduce supply uncertainty, collaborative adaptation of product development, use of postponement strategies, and intensive management of upstream sourcing activities through 'buying to order' to enhance supply responsiveness. The objective is to stimulate demand and promote sustainable market diversity by leveraging demand-driven supply chain operations focusing on close collaboration with local suppliers. Table 1 below presents a summary of the existing competitive strategies of GSCM and their associated supply chain characteristics.

GSCM strategies	Drivers	Objectives	Attributes	References

lean and efficient green	Legal regulations, pressure of compliance	• Ensure compliance • Reduce waste and cost	• Supply-driven and intra-oriented • Internal and integrated environmental management with lean practices • Indirect green performance	Bowen et al., 2001; King and Lenox, 2001; Zhu and Sarkis, 2004; Srivastava, 2007; Corbett and Klassen, 2006; Kleindorfer et al., 2005; Seuring and Muller, 2008; Kurdve et al., 2014; Dubey et al., 2015; Lee et al., 2016; Kumar and Rodrigues, 2017; Graham, 2018
Sustainable value seeking	Customer demand, new market	• Develop new market • Create value	• Demand-driven and inter-oriented • Green marketing and product practices • Direct green and value-added performance	Hart and Milstein, 2003; Ginsberg and Paul, 2004; Handfield et al., 2005; Markley and Davis, 2007, Seuring, 2009; Sharma et al., 2010; Sharma and Iyer, 2012; Silva et al., 2018; Ahmad et al., 2018; Liu et al., 2019

Table 2: Major GSCM strategies and associated supply chain characteristics

GSCM operational and design elements

GSCM practices cover a wide range of activities from greening upstream sourcing and procurement, inbound production and operations management, to outbound logistics, downstream transportation, packaging, warehousing, close-loop reverse logistics, remanufacture and recycling (Sarkis, 2012). They are generally discussed in the aspects of supply chain operations, relationship management and product design (see Table 2).

Dimension	Element	Practice	Reference
Operation	Greening inbound production and operations management, disposal and treatment operations	Lean production, environmental and quality management	Srivastava, 2007; Carvalho et al., 2011; Corbett and Klassen, 2006; Lenox et al., 2000; Srivastava, 2007; Sarkis, 2003; Kurdve et al., 2014; Graham, 2018.
Relationship management	Greening upstream material sourcing with suppliers, greening downstream packaging distribution and services with customers	Build-to-order lean system and total quality management system	King and Lenox, 2001; Rothenberg and Maxwell, 2001; Ragatz et al., 2002; Pil and Rothenberg, 2003; Carvalho et al., 2011; Mollenkopf et al., 2010; Kumar and Rodrigues, 2017; Dües et al., 2013; Miguel & da Fonseca, 2015; Colicchia et al., 2017; Garza-Reyes et al., 2016

Holistic configuration	Incremental and radical product eco-design	Design for easy repair and reuse via process redesign; design for clean technology	De Bakker and Nijhof, 2002; Kleindorfer et al., 2005; Zhu et al., 2013; Sharma et al., 2010; Kurdve et al., 2014; Ahmad et al., 2018; Graham, 2018; Melander and Pazirandeh, 2019

Table 3: GSCM operation, relationship management and product design

Greening inbound production and operations management is mostly discussed at the early stage of GSCM adoption for business to comply with environmental regulations and prevent pollution (Kleindorfer et al., 2005). Boudreau et al. (2003) discuss that early operators faced heavy fines or even had to cease operations if they exceeded certain regulatory limits on air- or water-borne emission. EMS were developed to monitor process continuously to detect and rectify situations before they got out of control and led to costly fines (Corbett and Klassen, 2006). In modern times, manufacturers are forced to manage end-of-life product disposal or recycle treatment operations with introductions of new environmental regulations (Kurvdve et al., 2014).

Greening upstream material sourcing with suppliers and downstream packaging distribution and services with customers are considered at the subsequent stages of GSCM to increase supply chain stakeholder value through collaboration by environmental management (Hart and Milstein, 2003). Kleindorfer et al. (2005) posits that greening of supplier base is distinct from greening compartment purchasing process in that it involves changes to the product supplied. Their study suggests that collaboration with suppliers on product-based green supply chain not only focuses on raw material innovation but also controls supply by-products, such as packaging and use of recycling materials.

By working closely with customers, demand-oriented supply management can be implemented at downstream (Carvalho et al., 2011). The use of build-to-order lean systems changes traditional push operations by on-time ordering, integrated production and delivery network planning leading to system surplus reduction in input of material, components and finished goods inventories (Colicchia et al., 2017). Researchers (Melander and Pazirandeh, 2019) also discuss role of distribution flexibility at the customer side cooperation for a value-added green impact. Similarly, Lemile (2019) suggests that greening outbound logistics services via downstream distributor and customer collaboration helps firms to reduce excessive volume packages and enable effective product maintenance and takeback that extend product life and augment internal control of close loop resource flow.

Eco-design instils a higher level of green effort, provided direct green value and performance, by focusing on supply chain configuration design that incorporates incremental process and radical product eco-design. Sharma et al. (2010) suggest that incremental innovation tends to serve mass market which is built on existing supply chain processes, relationships and capabilities to promote sustainability, and make green product affordable. The aim is to accommodate economy disruption and fully exploit resource in existing system while encourage sustainable value increase. Sharma and Iyer (2012) highlight the impacts of incremental green process innovation on economy efficiency in which resource constrained product development and volume market fulfilment is stressed.

Process redesign such as modularity is largely utilised by electronics supply chain to enable high variety of mix assembling and end-of-life easy disassembling (Kumar et al., 2016). Supply chain mix flexibility is infused at product design stage that preserves and enhances product value across the whole lifecycle. Comparatively, radical eco-design presenting a significant break from the conventional resource-intensive product design, supply and consumption, is suggested for business to stimulate premium innovation and create a new competitive model for sustainability, such as renewable energy (Ahmad et al., 2018).

Designing a conceptual framework

Existing studies discuss the strategic relationship between supply and demand. However, specific operations or processes of GSCM for strategic fulfilment are not fully investigated. With GSCM concept extending to close loop management, and full product lifecycle management

(including disposal, repair, reuse and recycle), *how* firms can deliver an integrated operation and manage relationships with external partners for sustainability is critical. Based on the discussion in the previous section, a conceptual framework linking the strategic and the operational levels of GSCM is proposed in Figure 1.

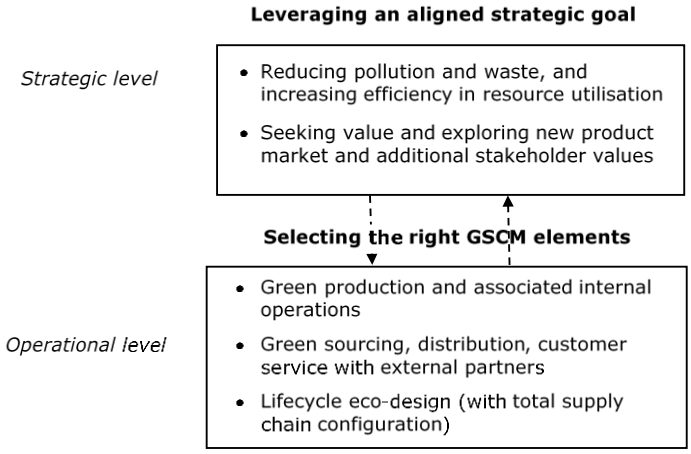

Figure 6: A conceptual framework for GSCM

METHODOLOGY

This study adopts a qualitative approach. As the research question is largely exploratory and attempting to investigate a new research context, a qualitative approach provides researchers with access to deeper levels of understanding of new and complex phenomena (Yin 2008). GSCM agenda integrating EM into industrial supply chain and product management is still at a nascent stage of market development in China (Zhu and Lai, 2019). In-depth case study allows us to explore deeper levels of intention and motivations for the changes and access to richer information to inspire theory building under a new context (Yin 2008).

This study selects one of the largest multinational ICT companies, an early adopter of GSCM in China, that led the domestic consumer electronics market environmental reform. The company is listed as one of the top organisations for industry environmental transformation and has long earned a reputation for sustainable corporate governance recognized by the government. We investigated specifically into the company's four key product lines: i) premium PC and laptop, ii) tablets and smartphones. iii) generic workstation and server, and v) fast consuming accessories. The study has drawn on multiple sources of information including semi-structured interviews, on-site observations, reviews of business news, reports and databases. Interviews were carried out with the key personals from the EM team, a cross-functional team responsible for various green aspects of material sourcing, product design and lifecycle management, in line with other business units. We also interviewed the ground floor team responsible for assembling production at factories, one of the key OEM suppliers and product R&D team located in China. In total, 11 in-depth interviews with numerous onsite visits as well as follow-up online meetings and phone calls were conducted.

We adopted thematic coding analysis (Eisenhardt and Graebner, 2007) using Nvivo software followed by thorough within-case and cross-case comparison for data analysis. Initial open coding was conducted by grouping phrases, sentences or paragraphs into codes and categories in an inductive fashion. Indicative coding categories were derived from theoretical background. Cross-case analysis helped to identify common themes and differences on how different dimensions of GSCM practices could impact on different product units.

FINDINGS

The following sections present the findings of the in-depth case studies across four unique product lines. The cross-case comparison results from each GSCM dimension are also discussed. Table 3 shows the findings of the case studies.

Green internal production and associated operations

Lean and green impact is widely observed in local factories, producing standard generic products, such as traditional desktops, workstations and servers. Lean has long been adopted in desktop computer assembling line and also linked to the key suppliers' material resource and

inventory management system. This includes bulk packaging design, pallet optimisation in warehouses, and transportation planning with suppliers to improve upstream volume efficiency. Waste reduction across functional departments, such as sourcing, assembling, inventory management and packaging activities working under the assemble-to-stock operation, can be leveraged.

At downstream, we observe that firm has started to offer product internal buyback programs and recycle operations since 2018. It partners with an external authorized local recycler for its recycling requirements. This is especially prevalent in general workstations and servers that are sold to corporates in large quantities. The cost of internal buyback is rather low; economy of scale in recycling can be achieved despite a thin profit margin. The company builds close relationships with corporate users by offering on-time maintenance and direct scale buyback. In contrast, premium fashionable products i.e., tablets and phones are harder to buyback. Personal users can dispose their products via other means, such as external commercial collectors, who will pay a price higher than through firm's own buyback programs. The cost of operating internal disposal and direct recycle of high-value units is also rather high at the current stage.

Green sourcing with external suppliers and servicing with customers

The company emphasises on supplier collaboration for green/durable material sourcing for its high-value product units. According to the interviewees, company sources from green suppliers for non-hazardous and recyclable materials for high-value laptop and PC production. It introduces Post-Consumer Recycled Waste (PCW) plastics instead of raw plastics for component design. The proportion of PCW to new materials can reach 40 to 50% per item. The company also works with suppliers on recyclable material packaging that are popular with high end global consumers.

Due an emerging ungoverned second-hand market for technological devices, the company has worked with external commercial collectors and redistribution platforms since 2019 to enhance control of end-of-life product buyback and resource flow, reduce illegal disassembling of its components, prevent unauthorized repairs being carried out, and avoid other commercial entities from remarketing its high-end used products and components.

For generic fast consuming or perishable products, e.g., accessories, green material sourcing is less considered due to the high cost of green materials on the current market. It was noted that recycled/green materials are costly to obtain in China compared with raw materials. This could be attributed to the lack of suppliers that specialized in such green materials as well as the lack of demand from end-consumers for green (or recycled) products in the fast consuming or perishable categories.

The extension of product shelf-life, via offering repair programs and maintenance services for its corporate users, has allowed the company to green (or lessen) its consumer demands for newly manufactured products. Desktop computers are mostly purchased by corporates that are more likely to purchase in bulk volume and use the products longer. The company focuses on building long-term relationships with these users offering them free repair of key parts (including processor, memory, cards and drives and regular software upgrades and service supports) and encouraging end-of-life scale returns. In this way, volume order efficiency can be leveraged while preserving value through upgraded services.

Supply chain and product eco-design

The company leverages on eco-design for its most high-end product lines. Among them, radical innovation is further leveraged in premium long-term products, such as PC/laptops, whereas incremental innovation is leveraged in short-term products, such as mobiles. Radical innovation includes introduction of clean material and energy programme and lifecycle analysis. For example, at material level, 97% of laptop products have introduced recyclable and higher durable materials that have zero impact on environment. From an energy innovation perspective, eco-design includes improving power energy efficiency, portable design and smart charging, LED lights and ergonomics design. For instance, its most popular products are high-end laptops that are light and thin, multi-functional, and have a battery life that is 30% longer than the previous generation. The entire series of products have exceeded 15%-25% of the energy efficiency standards defined by the US Energy Star. This series of products have been

well received in the global high-end PC market. The company works with global suppliers and original equipment manufacturers for competitive clean innovation.

For phones and tablets with shorter life, eco-design focuses on easy repair or reusable product structure to maximise existing value. For instance, through modifying component to high modularity, green value across the lifecycle supply chain can be better utilised and sustained for longer term rather than conducting high-risk disruptive structural innovation. By working closely with consumers and repair service points, the company can enhance green consumer awareness on product take-back, repair and reuse and promote upgraded durable consumption. For generic and low value products, structural eco-design is less considered. Incremental process upgrade for system efficiency and waste reduction while not compromise product basic functionality is observed in limited areas.

GSCM strategic alignment	**Internal operation**		**External operation**			**Eco-design**	
Key elements	Green production operations	Green disposal/ direct recycling	Green supplier relationship	Green customer relationship	Collaborative product repair or remarketing with distributor	Incremental process innovation	Radical product innovation
PC and laptop (high value/long lifecycle)	**+**	**+**	**++**	**+**	**+**	**+**	**++**
Tablet and phone (high value/fast fashionable)	**+**	**Ø**	**++**	**+**	**++**	**++**	**+**
Workstation and server (high volume/long lifecycle)	**++**	**++**	**+**	**++**	**+**	**+**	**Ø**
Accessories (high volume, fast-moving)	**++**	**++**	**Ø**	**Ø**	**Ø**	**Ø**	**Ø**

++ means this practice is being highly considered, + means this practice is being considered to a limited degree, ∅ means this practice is not being considered.
Table 4: Cross-case comparison in four product lines

DISCUSSION

The cross-case comparison findings show that differentiated supply chains can follow different paths to GSCM adoption as shown in Table 3. We find that for high-volume/low-value products, volume efficiency and waste reduction to cut cost is the key priority for business GSCM. In such case, lean production operations and green for baseline operational control are prioritised. This finding aligns with that of previous studies (Brindley and Oxborrow, 2012; Piercy and Rich, 2015; Kumar and Rodrigue, 2017), and enriches the existing GSCM literature by specifying linkage between volume product and lifecycle GSCM. For long lasting generic products, business can also add extra service and build long-term relationships with consumers whereas for fast consuming generic products, volume-based recycling can be considered for total resource efficiency. Despite a thin margin is obtained per product, firm can still leverage economy of scale to increase profit through mass production and recycling.

Also, the findings corroborate with the results of previous studies (Graham, 2018; Kurdve et al., 2014; Melander and Pazirandeh, 2019) and demonstrates that for high-value/low-volume product, sustainable value creation across the supply chain is the key. Thus, eco-design and dynamic supply chain sustainable relationship development are highlighted by the company to enhance green market expansion and creation. It further contributes to knowledge by revealing the linkage between high-value product and lifecycle GSCM. For high-end fashionable products, the company can focus on quick production reconfiguration with modular design, demand and supply system responsiveness by stakeholder integration to expand market, and easy repair functionality to exploit second-hand market value (Sharma et al., 2010). These emphases on the gradual enhancement of variety and delivery efficiency, sustainment of value of product across system, and improve design for higher durability. For premium products with sustainable character, the company can focus on new innovation each as energy and material programme/supply chain restructure to leverage niche benefit since these products are regarded as the driving forces of profits (De Bakker and Nijhof, 2002). Such capability is developed through close collaboration with component suppliers, original equipment manufacturers and external global partners. Based on the findings, a taxonomy of GSCM strategy with some practical guidelines for business producing different types of products highlighting the foci and the key elements are proposed (see Figure 2):

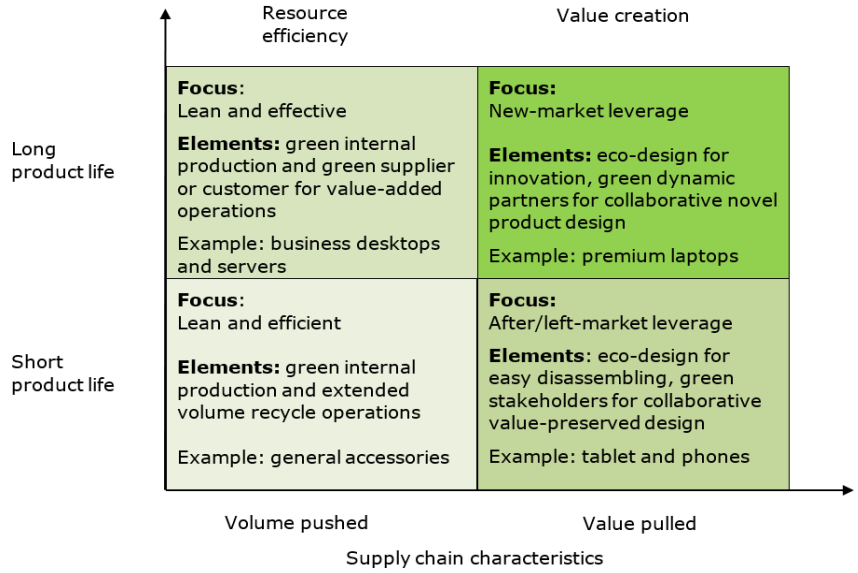

Figure 2: A taxonomy of GSCM strategic alignment on product types

- For value-pulled and long-life product range, the GSCM focus can be on new-market leverage strategy in which elements of eco-design for clean technology, green suppliers and dynamic partners for collaborative design can be promoted.

- For value-pulled and short-life product range, the GSCM focus can be on market expansion strategy in which elements of incremental eco-design for process redesign, green stakeholders for collaborative management can be promoted.
- For volume-pushed and long-life product range, the GSCM focus can be on lean and effective strategy in which elements of lean internal operations and green customers for extended green service can be promoted.
- For volume-pushed and short-life product range, the GSCM focus can be on lean and efficient strategy in which elements of lean internal production and recycle to push scale economy efficiency can be promoted.

CONCLUSION

The contribution of this study is through an in-depth case study it confirms that the major GSCM strategies identified in previous research are actually adopted by the industry in practice. The findings enable the establishment of linkages between volume and value products and close-loop GSCM. The taxonomy developed based on these findings enables practitioners to develop appropriate strategies to align lifecycle green supply chain management with product types. Despite its significant contributions, this study also suffers from a few limitations. Firstly, the case study findings are generated based on data from one industry, despite electronics sector represents one of the key market contexts for GSCM and SCM researches. Future research can further examine the results with wider range of cross-industry analysis to improve theoretical generalisability. Secondly, research robustness can also be improved by examining wider range of case companies including all different sizes of firm and niches in future studies.

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A SYSTEMATIC LITERATURE REVIEW OF SUSTAINABLE PACKAGING IN SUPPLY CHAIN MANAGEMENT

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Purpose of this paper:
Sustainable packaging has increasingly become a major concern for consumers, governments, and businesses, who have raised the importance of reducing packaging waste, which has gained renewed importance and awareness due in part to the recent increase in use of disposables and single-use plastics as a side consequence of COVID-19. Rising consumer awareness of environmental protection and social impacts are resulting in added pressure on industries to implement sustainable packaging initiatives in efforts to minimise waste and maximise product value within the supply chain, in a strive towards sustainability and circular economy, which has now become the focus for actors and stakeholders that work towards achieving sustainability. This exploratory study has utilised quantitative analysis to deliver a systematic literature review of published journal papers in SCOPUS and WoS through time until 2020 with the aim to present a comprehensive accord of research focus conducted in the sustainable packaging domain within the scope of supply chain management (SPSCM).

Design/methodology/approach:
This research was conducted with the data mining software, NetMiner 4, utilising three analytical tools of statistical analysis, keyword network analysis, and topic analysis. The research also utilised qualitative method of in-depth interviews to validate the analysis results.

Findings:
The research findings indicate that SPSCM research had been previously extremely limited, and has increased significantly since 2013, with research trends becoming increasingly diversified and gradually aligning with the concept of circular economy, as sustainable packaging is gaining significant importance. The keyword frequency analysis reveals the following highest occurring keywords in TF: life cycle; environmental impact; consumer; transportation; and production. The highest occurring keywords in TF-IDF: production; transportation; consumer; food; and environmental impact. Topic modelling revealed the following six topics: consumer behaviour; environmental pollution; circular economy; waste management; resource conservation; and operational management, with the topics of circular economy and waste management gaining attention, as sustainable packaging is gaining importance due to trade patterns of global supply chains, the emergence of e-commerce, and raised consumer awareness.

Value:
This study can be utilised as a foundation for further research development.

INTRODUCTION

Packaging development has initiated along with the need to transport and distribute goods, as often the source of production and manufacturing differs from the point of end use, and therefore, the need for packaging has become adjacent with the processes and journey of products from point of origin and throughout the supply chain journey to point of consumption. The packaging industry has a significant impact on the environment and on cost efficiencies across supply chains, including packaging design development phase, materials procurement phase, and end of life treatment phase (Pålsson and Hellström, 2016). Due to modern society's dependence on packaging properties and function to protect and deliver products, it has often been regarded as a necessary evil, associated with waste and detrimental effects on the environment, as once the product has been delivered, the packaging itself has fulfilled its function and its life cycle has come to an end (Lockhart, 1997). Packaging significance has increased rapidly, along with civil society and urbanisation. The correlation between the latter and product distribution with packaging has had an immense effect on all industries, as has consumer consumption behaviour, and as such, a heavy burden on the environment (Pongrácz,

2007). Packaging and sustainability share a two-sided relationship, as packaging may not be able to fulfil the inherent expectancy that is rooted in the notion of sustainability, due to it being designed to be disposed of once it has fulfilled its basic functions, and as such, the energy required for producing packaging may not correspond with its relatively short lifespan (UNEP, 2015).
Systematic Literature Reviews (SLR) addressing Sustainable Packaging in Supply Chain Management (SPSCM) have been limited, with no previous research utilising data mining techniques for analysis. This exploratory research utilises quantitative analysis employing SLR methodology to analyse published journal papers in SCOPUS and Web of Science (WoS) in order to present a comprehensive accord of research focus conducted in the field of SPSCM by utilising the data mining software, NetMiner 4.0. The analysis employs three analytical tools including statistical analysis, keyword network analysis, and topic analysis, in order to provide deeper understanding of current SPSCM status and research trends.

SUSTAINABLE PACKAGING

Sustainable packaging has been gaining momentum with stakeholders demanding change across all sectors to shift towards sustainable packaging alternatives (Cherian and Jacob, 2012) and an increasing number of organisations moving towards creating an ethical packaging industry that considers the environment and social aspects of the industry, as well as considering the economic aspects of packaging (Kozik, 2020). Sustainability has become a prominent feature for packaging in addition to performing its fundamental functions, with the packaging industry considered to be the link between economic growth and environmental issues. Sustainable practices along the supply chain are realised as means to advance facilitating the 3R principles, reuse-reduce-recycle, and incorporating the fourth R of renewal. However, these practices remain challenging with the conspicuous non-degradable plastic packaging remaining in the natural environment (Marsh and Bugusu, 2007). Businesses and organisations are setting goals and commitments to adopt sustainable practices and invest in packaging optimisation to answer consumer demands and to further enhance packaging efficiency and effectiveness (McKinsey, 2020). Industry efforts to implement sustainable packaging necessitates a reassessment of packaging fundamental functions to address the aspect of sustainability (Boz *et al*., 2020).

2.1 Sustainable Packaging Definition

Packaging refers to an enabling system designed to protect and ensure the effective and efficient transport, handling, and storage of a product throughout the supply chain (Hellström and Saghir, 2007). It has been playing a pivotal role in the economy by enhancing product safety and shelf-life, and therefore its definition is expanded further beyond a simple denotation of a material to contain and preserve the product to that of a coordinated system designed to prepare and protect goods along the supply chain while ensuring efficiencies and optimised sales (Coles and Kirwan, 2011). Sustainable packaging has previously often been referred to as green packaging, which denotes to the general performance of the package, as well as retaining the function of protecting the environment and using renewable resources (Orzan *et al*., 2018). Sustainable packaging also indicates that the packaging materials have been sustainably sourced and produced, and once it has served its purpose, holds the potential for resource recovery through recycling practices or by possessing compostable properties. Furthermore, social and economic principles are addressed in order to comply with guidelines for sustainability (Emas, 2015).

Principles to be met are often referred to those presented by the Sustainable Packaging Coalition as follows: (1) Is beneficial, safe & healthy for individuals and communities throughout its life cycle, (2) Meets market criteria for performance and cost, (3) Is sourced, manufactured, transported, and recycled using renewable energy, (4) Optimises the use of renewable or recycled source materials, (5) Is manufactured using clean production technologies and best practices, (6) Is made from materials healthy throughout the life cycle, (7) Is physically designed to optimise materials and energy, (8) Is effectively recovered and utilised in biological and/or industrial closed loop cycles, as well as those presented by the Sustainable Packaging Alliance: (1) Effective: Reduces product waste, improves functionality, prevents overpackaging, reduces business costs, achieves a satisfactory return on investment (ROI), (2) Efficient: Improves product/packaging ratio, energy, material, and water efficiency, increases recycled content, reduces waste to landfill, (4) Cyclic: Returnable, reusable, recyclable, biodegradable,

(3) Clean: Reduces airborne, waterborne, and greenhouse gas emissions, reduces toxicity and litter impacts.

A broader definition of sustainable packaging was introduced to incorporate the concept of sustainable packaging in SCM with Sustainable Packaging Logistics (SPL) that offers advanced approaches to reduce issues rising from a burdened packaging logistics network. The approach is considered particularly innovative, as it considers the concepts of development, logistics, packaging and sustainability altogether (García-Arc *et al*., 2017). SPL incorporates the process of designing, implementing, and monitoring the integrated packaging, product and supply chain systems in order to prepare goods for safe, secure, efficient and effective handling, transportation, distribution, storage, retailing, consumption, recovery, reuse or disposal, with a view to maximise social and consumer value, sales, and profit from a sustainable perspective, and on a continuous adaptation basis. SPL is regarded as a progressive procedure to assess each phase of packaging in the supply chain that is designed to boost sustainability (García-Arc *et al*., 2014).

2.2 Sustainable Packaging Development

Sustainable packaging has increasingly become a major concern for consumers, governments, and businesses, who have raised the importance of reducing packaging waste, which has gained renewed importance and awareness due in part to the recent emergence of COVID-19 that has seen an increased demand for single-use products and packaging usage, resulting in excessive packaging waste (Noel, 2020). COVID-19 has been changing trends and readdressing health and safety concerns for the packaging industry, resulting in added pressure on industries to implement sustainable packaging initiatives in efforts to minimise waste and maximise product value within the supply chain, in a strive towards Circular Economy (CE), which has become a focal point for stakeholders. Trends shaping modern society's sustainable packaging demand is pressuring industries and SCM to rethink packaging to incorporate optimised, automated, and smart solutions to increase packaging sustainability (DHL, 2019). Packaging design development is growing to incorporate the indispensable need for protecting the product, while also prioritising a balance for consumer ease of access (Rundh, 2009). Consumers have increasingly become accustomed to expect considerable higher levels of service standards, which have been raised by innovative market leaders in e-commerce to accommodate consumer preferences (Vasić *et al*., 2019) and concerns of inefficient and wasteful practices, stimulating new prospects for packaging innovation (DHL, 2019). Technology emergent in smart packaging is designed to address such concerns by incorporating intelligent and active solution with functions that can also assist in decision making by providing product information (Kerry, 2014), as is active packaging that enables longer shelf life, and intelligent packaging that provides package content information (Kuswandi, 2017). Bans and regulations on disposable plastics are anticipated to further increase the adoption of alternative packaging materials (European Commission, 2020), with reusable packaging in particular, gaining momentum (Keoleian and Spitzley, 1999), as it enables reduction of material usage and costs, in a drive towards a closed-loop system (Ellen MacArthur Foundation, 2018).

METHODOLOGY

The research methodology adopted in this study is a SLR adapted and revised from previous recent research (Ki *et al*., 2020; Meherishi et al, 2019; Govindan and Hasanagic, 2018; Padhi *et al*., 2018) with the introduction of network analysis methods that serve to explore future research direction and trends in novel fields (Akter and Wamba, 2019). In the first stage of the research, a review of previous literature was conducted in order to establish the analysis framework. In the second stage, three semi-structured in-depth interviews with experts in the field of sustainability and packaging were conducted to evaluate and reaffirm the initial framework. In the third stage, the data analysis was conducted by utilising two quantitative methods, SLR and big data analysis, which coupled with the in-depth interviews, form triangulation to validate the research results and to raise the level of confidence in the research by employing three different methodologies. The qualitative research technique of in-depth interviews encompasses exploring the perceptions of few individuals on a specific concept (Boyce & Neale, 2006), as the nature of the open-end questions allows to discover and explore interviewee's emotions and perceptions on the topic (Guion, Diehl, & McDonald, 2011). The interview procedure employed the following four essential steps adopted from the Wallace Foundation (2009, p. 3-4): "(1) developing a sampling strategy; (2) writing an in-depth

interview guide; (3) conducting the interviews; and (4) analysing the data". The interview results of three participants have been recorded and analysed for this study: (1) a CE and sustainability strategist with 3 years of experience based in the UK; (2) a CE lecturer with 9 years of experience based in the UK, and (3) a packaging researcher in the FMCG industry with 8 years of experience based in South Korea.

The data analysis procedure for this study composed of analysing articles sourced from SCOPUS and WoS databases, which are regarded as leading citation databases with peer-reviewed journals (Adriaanse and Rensleigh, 2013) containing articles in relevant fields to the research. The search was conducted with three keyword search string combinations related to sustainability/CE, packaging, and SCM, which have been identified through the literature review process, with additional operators applied using the title, abstract, and keyword options to retrieve all previous research, including articles and articles in-press published in English. In order to screen articles, the PRISMA protocol for inclusion and exclusion criteria was employed, ultimately resulting in a total of 176 articles related to SPSCM in the final sample that were published between the years 1993 and 2020. The articles were then analysed with the software program, NetMiner 4.0. NetMiner has enabled the extraction of keywords from article abstracts by conducting a pre-process procedure with the application of three dictionaries to extract unstructured data and filter irrelevant words. The keyword frequency analysis was conducted by applying a Term Frequency (TF) value and Term Frequency-Inverse Document Frequency (TF-IDF) value, followed by a keyword network analysis to quantitively analyse the structure of the network, identify the relationship between keywords, and to measure the keyword frequency. TF and TF-IDF were also utilised for centrality and betweenness analysis in order to identify research trends according to the keyword degree centrality and betweenness centrality measurement. Finally, topic modelling was conducted using the Latent Dirichlet Allocation (LDA) algorithm in order to reveal and identify emerging topics in SPSCM.

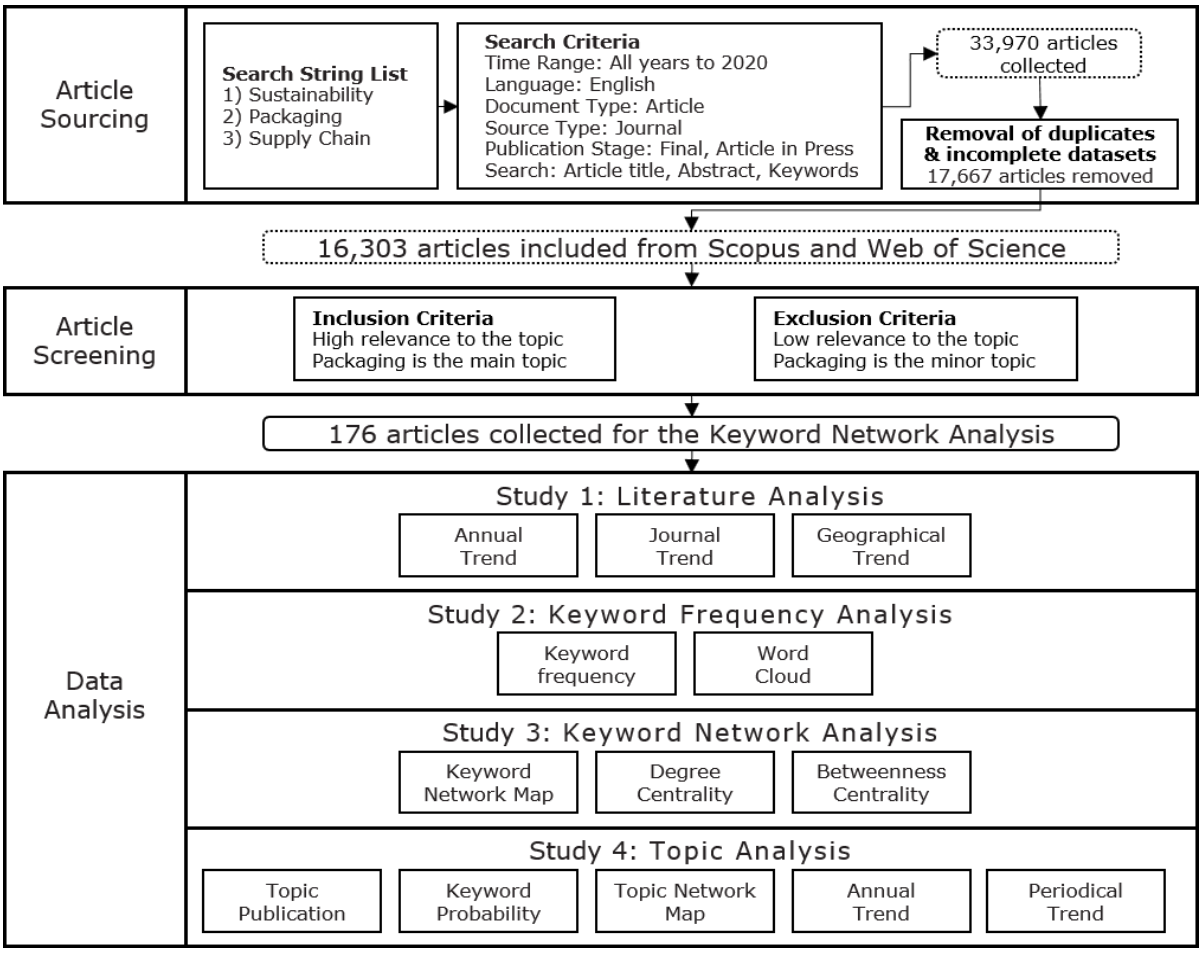


Figure 1: Systematic Literature Review process

RESULTS

4.1 Results of Literature Analysis

Analysis of the 176 articles collected from SCOPUS and WoS reveals an extremely limited number of publications prior to 2011, with articles published from 1993 to 2000 accounting for a total of 6 papers (3.41%), articles published from 2001 to 2010 accounting for a total of 24 papers (13.64%), and articles published from 2011 to 2020 accounting for a total of 146 papers (82.95%). Articles published in 2020 alone accounted for 36 papers (21.18%), indicating a significant and rapid increase in SPSCM research publications in recent years.
The top five journals with the highest number of publications were identified as follows: Journal of Cleaner Production (25), Packaging Technology and Science (21), Sustainability (Switzerland) (16), International Journal of Life Cycle Assessment (15), and Resource Conservation and Recycling (8). Regions with the highest number of publications in accordance with the corresponding authors were identified as follows: Europe (112), Asia (28), North America (14), South America (10), and Oceania (7). While the top five countries with the highest numbers of publications were identified as follows: Italy (30), Spain (19), United Kingdom (14), China (11), and Brazil (10).

4.2 Results of Keyword Analysis

The keyword frequencey analysis produced an initial total of 1,885 keywords prior to applying the three dictionaries including the thesaurus, defined keywords, and exception list, resulting in a total of 618 keywords for analysis, which may indicate research trends in SPSCM. The top ten most frequent keywords in the TF analysis were identified as follows: life cycle (138), environmental impact (117), consumer (115), transportation (97), production (96), waste (87), food (86), sustainability (72), design (72), and life cycle assessment (71). The top 10 most frequent keywords in the TF-IDF analysis were identified as follows: production (66), transportation (61), consumer (52), food (47), environmental impact (46), waste (46), logistics (40), life cycle (39), bottle (35), and plastic (34). The keyword network analysis illustrated bellow in Figure 2, identifies connections between keywords and measures their importance according to their centrality by performing degree centrality and betweenness centrality analysis. The centrality analysis was conducted on four time periods between 1993 and 2020 in order to illustrate how keywords used in SPSCM research have become more diversified and interconnected thorough time, with the overall result of the 1993 to 2020 keyword network map illustrating the vast increase in keyword density in comparison with the other time periods.

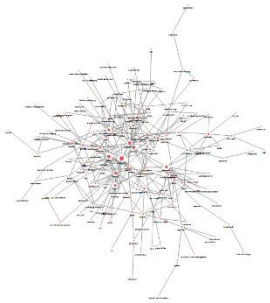
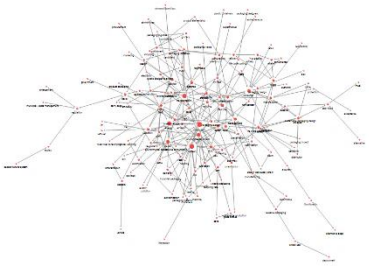
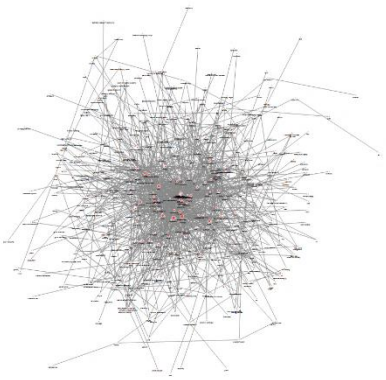
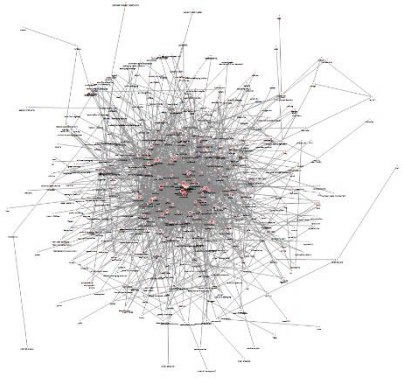
1993-2000 Keyword Network Map	2001-2010 Keyword Network Map
	
2011-2020 Keyword Network Map	**1993-2020 Keyword Network Map**
	

Figure 2: Keyword Network Maps

Since 1993 to 2020 the top ten keywords with the highest level of degree centrality have been identified by order as follows: production, transportation, consumer, food, environmental impact, waste, logistics, life cycle, bottle, and plastic. The top ten keywords with the highest level of betweenness centrality have been identified by order as follows: production, transportation, consumer, food environmental impact, waste, logistics, life cycle assessment, life cycle, and management. Keywords that possess both high level of degree centrality and betweenness centrality have been identified by order as follows: production, transportation, consumer, food, environmental impact, waste, logistics, life cycle, bottle, plastic, and distribution. The two keywords, 'energy' and 'sustainability' have been identified to possess a relatively low level of betweenness centrality but a high level of degree centrality, which means they act as hubs of subgroups rather than playing an important role in the flow of information within the network. While 'life cycle assessment' and 'performance' have relatively low level of degree centrality but remain to have high level of betweenness centrality, which means that they have higher influence on the flow of information that may lead to research convergence on certain topics (Hoser et al., 2006).

4.3 Results of Topic Analysis

Topic modelling has captured the latent distributions of keyword distributions in the articles to discover statistical regularities by revealing six topics consisting five individual networks of keywords with the highest probability and no overlapping keywords as follows:

1. consumer behaviour: containers, efficiency, coffee, disposal, packaging, design.
2. environmental pollution: reduction, emission, fruit and vegetables, CO2e, GHG.
3. circular economy: circular economy, food waste, resource, energy, carbon footprint.
4. waste management: plastic, logistics, packaging system, crate boxes, end of life.
5. resource conservation: distribution, bottle, life cycle assessment, glass, PET.
6. operational management: design, performance, reverse logistics, recycling, consumption.

Articles may be composed of multiple topics and the allocation of a specific article to a topic was conducted by identifying the highest probability of a topic appearance in a given article. The topics with the highest distribution among articles are in the following order: waste management (39), circular economy (32), environmental pollution (31), resource conservation (28), consumer behaviour (28), and operational management (18). The time period series development reveals that topics have become more diversified and evenly distributed since 2011. Resource conservation was the most studied topic between 1993-2000, and remained so between 2001-2010 along with operational management and consumer behaviour. Waste management was the most studied topic between 2011-2020 along with environmental pollution and consumer behaviour, with the initial two having gained further significance in the last five-year period.

4.4 Results of In-Depth Interviews

Technological innovation, cost efficiencies and alternative packaging material development have been highlighted in the interviews as critical factors for success to transition towards sustainable packaging solutions. Consumer awareness, government policies, and collaboration among stakeholders have also been discussed as key factors for innovation that contribute towards implementing sustainable packaging initiatives along the supply chain, which in return promote brand image and increase brand loyalty. Packaging is perceived as the largest contributor to waste generation, and with the dramatic increase in both awareness and use of single-use packaging due to COVID-19, consumer demand and pressure on governments and industry for change has increased, which are in turn realising opportunities for collaboration in order to address these issues.

CE processes are growing to become the biggest trendsetters in the sustainable packaging field with the topic most often discussed in the context of FMCG, and as consumers become more aware of environment and food safety issues, trust in plastic packaging, which has little room in CE, is diminishing. Consumer conception of plastic, which tends to be scrutinised the most, raises concerns, as it can result in companies adopting alternative packaging that may not always be a sustainable option, as plastic remains to be a flexible material essential for all supply chain processes, and thus, the need to develop technologies and solutions to circulate the material. Green packaging may not always be sustainable and may even increase the overall negative impact of a product. The 3R principles and CE are currently considered to be the main focus for sustainable solutions with industries encouraged to adopt measures to

develop packaging design through the use of life cycle assessment tools. The packaging industry is developing solutions to fit circular concepts that will remove packaging from waste streams, with chemical and mechanical recycling solutions introduced, as governments are introducing new policies and initiatives for waste prevention. Industries are encouraged to adopt measures directed to develop packaging design and make improvements to packaging production through extensive use of life cycle assessment tools, with further policies and legislations expected to be introduced to tackle packaging, in particularly plastics.

CONCLUSIONS

The systematic literature review was conducted by utilising data mining tools in order to systematically grasp research trends for future research agenda in SPSCM. Sustainable packaging research has been limited in the fields of science and engineering. However, the topic has gradually gained more attention since the turn of the century from diverse fields due to trade patterns of global supply chains, the emergence of e-commerce, and raised consumer awareness, along with government regulations. Sustainable production and consumption advance the concept of reducing waste and increasing resource efficiency to maintain a healthy economic growth separate from environmental degradation. COVID-19 has provided the world with an opportunity for substantial transformation to a more sustainable economy that can benefit both people and the planet, as it further highlights society's relationship with nature and exposed fundamental principles of the predicament that the world is facing of addressing human needs while the planet resource is limited in its capacity to satisfy those wants and needs (United Nations, 2020).

In the keyword analysis, 'food' and 'consumer' have been reoccurring keywords, which are correlated with consumptions habits and the fundamental function of packaging protecting food products, coupled with increasing demand for home food deliveries due to lockdowns and social distancing measures, resulting in increasing demand for sustainable packaging solutions. CE has seen significant change, with the concept becoming popularised in the last decade, while waste management and environmental pollution topics have also seen significant growth. Future research should expand to more diverse academic disciplines, with the topic of operational management having been identified to require more attention.

Findings in this study may contribute by providing further insight to the current status and research trends for the future development and implementation of sustainable packaging in supply chain management by identifying important keywords, so that appropriate sustainable practices are developed and implemented along the supply chain. Academia and scholars may utilise research finding in order to better understand past, present and future research agendas in order to expand and further develop the field of study, as it is evident that there is growing interest in SPSCM. Finally, policymakers may refer to the identified keywords in this study that could prove essential for the topic agenda in order to develop and promote sustainable packaging policies and regulations.

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A CONTENT ANALYSIS OF THE BARRIERS AND CHALLENGES ASSOCIATED WITH THIRD PARTY LOGISTICS: A COMPARISON OF THE UK AND NIGERIA

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Purpose:
The aim of this paper is to identify, rank and compare the barriers and challenges associated with the practice of logistics outsourcing in the UK and Nigerian in order to find out why it is less practiced in Nigeria compared to the UK.

Methodology:
The research is an exploratory research using content analysis. Secondary data was gathered from various sources such as academic journals, business magazines, online newspapers, databases such as ABI/INFORM, GMID, World Bank database and statistical database websites such as Statista, Mintel, Ibis World, Armstrong and associates, Mordor Intelligence and ReportLinker. These foregoing sources were systematically searched and reports such as UK logistics industry reports, UK contract logistics company report, Nigerian logistics risk reports, Nigerian 3PL market report, academic journal reports, newspaper and magazine content and data from GMID and World Bank database were reviewed. The findings of the review were then ranked according to frequency of occurrence showing priority of barriers and challenges of 3PL in both countries.

Findings:
Findings show that UK logistics industry and 3PL market is more matured than the Nigerian logistics industry and that UK contract Logistics companies rank among the top logistics companies globally. Further evidence shows that UK logistics industry and 3PL market is forecasted to continue to grow slowly despite few mild challenges while the Nigerian 3PL market shows significant promising future. Furthermore, 15 barriers and challenges were identified in Nigeria while 6 barriers and challenges were identified in the UK with less frequency of occurrence. Among the top three major barriers identified in Nigeria are congested road networks and ports (7), security issues such as smuggling and robbery (7) and high rate of traffic accidents (6). In the UK the top three major barriers identified are: driver/labour shortages (2), rising fuel prices (2) and click and collect (1).

Value:
The research gives preliminary insights and explanations into the reasons for the lower level of logistics outsourcing in Nigeria compared to the UK by identifying and ranking the barriers and challenges of the 3PL market in Nigeria and the UK. While there are academic literature that have argued that logistics outsourcing is less practiced in developing countries than it is practiced in the developed countries such as the UK, other European countries and the USA, not many have been able to provide insights for the difference in levels of logistics outsourcing practice between a developing country such as Nigeria and a developed country such as the UK. The research is hence valuable to the logistics academia, 3PL practitioners in Nigeria and the UK and to any Nigerian or UK potential 3PL investor or customer.

Practical implications:
The results from this study can be used to inform the development of a Nigerian specific decision support framework/tool for organizations in any industrial sector wishing to contemplate the use of third party logistics products and services. It may also inform the investment decision of potential foreign 3PL investors in the UK and Nigerian market.

1. INTRODUCTION

The concept of third-party logistics refers to the outsourcing of all or some logistics activities to a logistics providing company or a 3PL company (Vasiliauskas & Jakubauskas 2007; Solakivi et al., 2011 & Li-jun 2012). The practice of third-party logistics emerged as a strategic business concept, which is based on outsourcing (Yang & Lindsay 2011). Several authors agree that third

party logistics is aimed at achieving efficiency in logistics management, reducing cost of logistics and enabling companies to concentrate on their core business thereby increasing overall organizational efficiency and productivity (Marchet et al., 2017; Adebambo et al., 2015; Yang & Lindsay 2011 & Li-jun, 2012).
Evidence shows that third party logistics is well practiced in the developed countries of the world like the UK, USA, and Europe compared to a lower level of activity in developing and emerging economies such as Nigeria (Dapiran et al., 1996; Sink et al., 1996; Solakivi et al., 2011; Lieb et al., 1993; Arroyo et al., 2006; Tian et al., 2010; Etokudoh et al., 2017; Onyebueke et al., 2019 and Adebambo et al., 2015).

Further evidence shows that there is a dearth of research on the use of third-party logistics in Nigeria hence the need for further research into the practice of third-party logistics in Nigeria (Etokudoh et al., 2017; Onyebueke et al., 2019). Furthermore, evidence shows that third party logistics practice exists in Nigeria as Mac-Kingsley & Ihunwo, (2018) showed that there is a strong presence of third-party logistics in port operations, freight forwarding, delivery and customs clearance and 3PL continues to evolve as it generated a revenue of $4.6 billion and $5.2 billion in 2018 and 2019 respectively (Armstrong & Associates, 2020; Statista, 2020). 3PL revenue of $5.2 billion represents 1.15% of GDP showing a significant contribution to the Nigerian GDP (Armstrong & Associates, 2020; Statista, 2020), which is comparable to some developed country cases such as the US which has a very robust 3PL industry and a market size in 2021 of $234 billion, expected growth rate of 3.9% and represents 1.17% of GDP.

Furthermore, Nigerian 3PL revenue in 2019 is the highest among all African countries both in figures and percentage. The entire African 3PL market generated a combined $28 billion in revenues in 2019 (Armstrong & Associates, 2020; Statista, 2020). However, literature acknowledges that the Nigerian 3PL market is still in its infancy stage (albeit with growth prospects) compared to the developed regions of the world, hence the need for further investigation into the practice of third-party logistics in Nigeria and the UK to understand the barriers preventing Nigeria's 3PL sector from developing into a mature market as well as making recommendations for further study (Etokudoh et al., 2017; Mordor Intelligence, 2020).

This paper uses a comparative content analysis that is aimed at identifying, ranking, and comparing the main barriers and challenges of third-party logistics in the UK and Nigeria in order to find out and provide explanations as to why it is less practiced in Nigeria compared to the UK.

2. REVIEW OF LITERATURE ON BARRIERS AND CHALLENGES OF 3PL IN THE UK AND NIGERIA

2.1 United Kingdom

A research study that was led by Georgia Institute of Technology along with Capgemini, DHL, and SAP in 2007, which aimed at finding out what users of 3rd party logistics wanted showed that 95% of transportation services, 76% of warehousing and 59% of custom's clearance and brokerage are outsourced in Western Europe (Macdonald, 2007, PR Newswire, 2017). Also, the study found out that in Western Europe with the UK in the lead, logistics costs as a result of logistics outsourcing was reduced by 11.4% and fixed logistics assets were reduced by 21.9% freeing up capital for other investments. The areas that needed improvements in Western Europe were service level commitments, which were only 50% realized, a lack of on-going improvements and achievements in logistics services that were being offered was 41% and the insufficiency of information technology capabilities were 38% (Macdonald, 2007).

In 2014, Cooper (2014) argued that unlike most retail stores and outlets in the UK, Amazon does not rely on 3PLs for their logistics operations partly because their brand identity is a very important part of their marketing strategy, which helps them to maintain their customer loyalty. Cooper (2014) further explained: "The problem is that the retailer is effectively handing over its brand to a third party. The customer only sees that part of the chain. Some retailers are a bit uncomfortable doing that and some people have talked about taking it in house" (Cooper, 2014, p.1). Cooper (2014) further points out that for most retail companies in the UK the

alternative to outsourcing are mostly too complex and expensive especially for fast fashion retail stores. Perhaps a better solution to the complexity of keeping logistics in-house, which is becoming more popular among fast fashion retail stores in the area of delivery, is click and collect. Cooper (2014) argues that click and collect is easier to manage for many fast fashion retail stores especially when the collection is in store because it can be built into existing supply chain infrastructure. However, it was also noted that some retailers such as Asda and Amazon have installed some collection points in car parks and in some London underground tube stations making click and collect a barrier to logistics outsourcing in the UK fashion retail sector.

SCALA (2019) noted that 20% of UK companies have reported an unsuccessful start to a logistics outsourcing contract according to a study that was carried out by logistics and supply chain consultancy firm SCALA. The research looked at logistics contract start-ups and found out that 15% of 3PL customers have experienced services that were lower than the expected outcome in the areas of cost, deliverables and lead-times. Another 5% had relationship problems with their 3PL company (Motor Transport, 2014). A further survey was done by SCALA of UK businesses and 3PLs whose revenues run into billions of pounds and clients run into the thousands to assess the level of satisfaction and areas of concerns regarding the performance of 3PLs. The survey showed that 54% of 3PLs rated their contract start-ups as highly successful in terms of timeliness or just-in-time logistics, seamless service (no or little supply chain disruption) and in terms of operating within budget or offering good quality, low cost service. On the contrary, only 34% of 3PL customers agreed to the foregoing claims by 3PLs (Motor Transport, 2014). The foregoing shows that the level of 3PL customer satisfaction is relatively low, reflecting a low level of effectiveness of third-party logistics companies in the logistics and supply chain management of a sizeable number of 3PL customers in the UK. This also reflects the fact that the UK third party logistics industry is faced with some common challenges and issues as reflected in the reports below.

According to the Global third-party logistics industry report 2020 by ReportLinker the UK was not among the major countries with significant growth projections in 2020. The total global growth was estimated at $495.6 billion at the end of 2020 which was driven mainly by the DTM (Distribution and Transport Management) segment as its global market value is expected to reach $577 billion by 2025 (ReportLinker, 2020). The report shows that the USA, China, Germany and Japan are the four major markets with the most significant growth projections. The US third party logistics market is expected to grow by 6.3%, while China is expected to grow by 9.2% adding $167.9 billion in growth to the global third-party logistics market in the next couple of years. Also, Germany's DTM (distribution and transportation management) is expected to add $14.2 billion to global DTM growth in the next few years up to 2025, while the rest of Europe is expected to add $21.4 billion to global DTM growth. Furthermore, Japan's DTM market is expected to reach $17.7 billion by 2025 (ReportLinker, 2020). The report listed the global top 18 third party logistics companies who are the major global competitors and will continue to be the major players during the projected period. Among these 3PLs none are UK owned. Six of these 3PLs are from the USA namely: C.H. Robinson, Fed Ex Corporation, Expeditors International of Washington, Inc., J.B. Hunt Transport services, Inc., XPO Logistics, Inc. and UPS Supply Chain Solutions Inc., while Japan has three 3PLs represented. Germany has three represented as well. Other countries represented are France (2), Netherlands (1), Switzerland (1) and Hong Kong (1) (ReportLinker, 2020).

The FTA (2019) noted that despite the uncertainty and disruptions caused by BREXIT, UK logistics companies are still very optimistic for the future. The total number of logistics companies in the UK in 2019 was 192,525 and almost 190,000 of these were SMEs. The industry saw growth in 2018 and the industry added 200,000 more jobs in the logistics sector. There was a strong occupational growth related to warehousing and storage because of an increase in online sales; however, the uncertainties of BREXIT led to labour shortages in several logistics areas especially in areas that are heavily reliant on EU workers. The report further described the logistics industry as the backbone of the UK economy by not only helping to move goods to and from different hubs and ports but also because it supports the construction, manufacturing and services sectors. The report confirmed that fuel prices are higher than they were in the previous year making it a major challenge to the industry. The report also confirms that congestion on road networks is also a challenge that affects the productivity of the logistics industry. The report further noted that warehousing continues to perform strongly with 14.7%

return on investment in 2017 and 11.7% in 2018 and annual growth in rental value grew to 3.1% at the end of 2018.

According to GMID - General Market Information Database (2020) and World Bank database (2020), the UK logistics performance index based on socio-economic indicators has consistently declined from 2014 to 2019 as they ranked 4th out of 160 countries, in 2014, 6th out of 160 countries in 2015, 8th out of 160 countries in 2016, 8th out of 160 countries in 2017, 9th out of 160 countries in 2018 and 11th out of 160 countries in 2019. This is also reflected in the financial reports of big UK logistics firms such as Wincanton logistics whose annual revenues have been fluctuating within the last 10 years and percentage profit margin has remained very low ranging from 2.28% to 5.74% within the last 10 years and in some years like 2011 and 2012 profits margin were negative at -1.19% and -3.94% respectively. The company turnover has remained at over 1.3 billion Euros since 2017. Nevertheless, Wincanton logistics is ranked number 3 out of 18 listed industrial transportation companies in the United Kingdom (Financial times, 2020). However, according to a Mintel (2018) UK logistical services report; the UK logistical services market is forecasted to grow steadily through to 2023, which will be driven by road freight. The following findings were made from the report below:

- The report confirms that rising fuel prices continues to be a challenge.
- Skills and driver shortages continue to pose a threat to the industry's ability to meet the continuous rise in demand of logistical services.
- Industry wide staff recruitment and retention will continue to pose a challenge to the growth.
- Demand for logistics space reached its high point in 2018, which continues to be driven by an increase in online sales and that 3PLs are seeking to further digitalize their operations because of the boom in their customer's online sales.

2.2 Nigeria

According to reports on logistics risk in Nigeria by BMI Research a Fitch Group company (2014, 2015, 2016, 2017, 2018 $ 2019), issues such as high congestion, high rates of traffic accidents and security issues such as armed robberies contribute to the risks of disruption in supply chains and impacts all logistics activities. Nigeria's logistics risks index score in the first quarter of 2018 was 30 out of 100 in a scale of 0-100 where 0 is the highest risk and 100 is the lowest risk. Also, World Bank database shows that Nigeria's logistics performance index (LPI) ranking was 110 out of 160 countries in 2018.

The BMI (2018) report noted that a high incidence of smuggling and other security risks further increases logistics costs, and the security control response further raises the risks of supply chain delay and rent-seeking activities. The report further noted: "Convoluted and costly trade compliance requirements, inadequate transport infrastructure and pervasive corruption at key entry points and along inland routes significantly dent Nigeria's logistical appeal" (BMI, 2018, p.6). Furthermore, the transport network in Nigeria is excessively reliant on road transport and hence the country's supply chain is forced to overly rely on the country's congested road networks and ports, which increases operational risks because of the likelihood of disruption. The BMI (2018) report further noted that despite the country's enormous oil wealth, it still has instances of energy and fuel shortages, which are also among factors that may lead to supply chain disruption. In the first quarter of 2019 the BMI's logistics risk report noted that Nigeria's overall score was 31.5 out of 100 in terms of logistics risk compared to 30 out of 100 in the first quarter of 2018 (BMI, 2019). This placed Nigeria's global logistics risk position at 165 out of 201 nations that were measured. The foregoing analysis and statistics show the high risks of operating logistics and supply chain services as a contract or third-party logistics firm.

Hence, foreign contract or third-party logistics firms are often deterred from entering the Nigerian market. Also, most large manufacturing companies, retailers and other industrial companies would rather keep their logistics in-house because of the foregoing risks which neutralizes the core benefits of contracting a third-party logistics firm such as cost savings, efficiency, and Just-In-Time operations (Adebambo et al., 2015). This is because the aforementioned risks such as continuous road congestion, high rates of traffic accidents and security issues causes disruptions and delays in the supply chain and makes it difficult for a

contract logistics firm to achieve lean supply chain services, efficiency and cost savings in the logistics and supply chain of their clients. Thus, the cost of hiring their services is often not justified, making their service offerings less relevant (Onyebueke et al., 2019; Boyson et al., 1997).

In addition to the foregoing risks reported by BMI (2019), some similar country specific challenges and barriers to third party logistics in the Nigerian Oil and Gas industry and manufacturing sector were identified in Etokudoh et al. (2017). They include poor infrastructure (road and port congestions), high cost of business operations, underdeveloped market, security challenges, host communities pressure/demands and uncertainty in the business environment (Adebambo et al., 2015, Etokudoh et al., 2017).
Onyebueke et al. (2019) noted that logistics outsourcing was formally recognized in Nigeria in 1989 and were majorly used by large-scale companies such as Coca Cola, Nigerian Breweries, ExxonMobil, Oando and Total Oil. Onyebueke et al. (2019) further notes that prior to that time these companies were handling their logistics in-house, which was putting them under severe pressure and at some point they even incurred huge business losses. Therefore, these companies started outsourcing some of their logistics functions where they have little or no competency in comparison with specialist third parties so that they can focus on their core operations, increase levels of flexibility and creativity in order to achieve efficiency in service delivery to clients and customers (Onyebueke et al., 2019; Etokudoh et al., 2017). Onyebueke et al. (2019) also noted that 85.6% of respondents in their study of logistics outsourcing in selected Oil and Gas companies (ExxonMobil, Total E&P and SPDC) in Rivers state of Nigeria strongly agree that outsourcing their logistics to third parties improved their service delivery.

Onyebueke et al. (2019) state that 80% of respondents in their study agreed that outsourcing their logistics have reduced overall operational costs (Etokudoh et al., 2017) because working with third party logistics drillers and engineers have helped to reduce overhead and labour costs, which coupled with the expertise that these third-party logistics engineers and drillers bring have enabled them to meet their set targets, bringing good levels of profits to their companies.

In the Etokudoh et al. (2017) study, 76% of respondents both from the Oil and Gas companies and from the 3PL companies agreed that there are benefits in logistics outsourcing. However, Onyebueke et al. (2019) notes that there are some challenges and problems of logistics outsourcing in the Nigerian Oil and Gas industry that were identified in their research. They noted that 67% of respondents agreed that lack of understanding resulting from a change in management of the 3PL customer may lead to poor service delivery, low productivity and failure of contracts. They further noted that respondents lamented on the poor handling of documents by 3PLs and mixing up of documents with documents of competitors (other 3PL customers) may lead to the risk of sharing of information/secrets with competitors. They further reported that respondents acknowledged that corrupt managers of 3PL customers may collaborate with the 3PL companies (based on percentage cuts) to include hidden charges in the account statement. This issue of dishonesty and corruption, which creates issues of trust may hypothetically be one of the barriers to the further use of logistics outsourcing in Nigeria and therefore requires further original research to confirm it. Also, 68% of 3PL customer respondents acknowledged that many 3PLs under pay their staff and many do not provide incentives and comfortable working conditions, which discourages their staff from performing and ultimately affects the quality of service provided by 3PL companies. The foregoing issue may also be a possible barrier to further logistics outsourcing in Nigeria, which requires further original research.

Etokudoh et al. (2017) notes that challenges of logistics outsourcing in the Oil and Gas industry in Nigeria include: information flow management (Lieb et al., 1993), JVP (Joint venture partnership) intervention, employees' reluctance to work with 3PL staff or problems related to staff changes, vendor (3PL) capability and differences in organizational cultures (Lieb et al., 1993) were identified by their research respondents in the Nigerian Oil and Gas companies and their 3PL providers. Some of the challenges that are mentioned above such as information flow management and differences in organizational culture are aligned with Lieb et al.' (1993) findings of general challenges associated with logistics outsourcing.

Furthermore, there are already risks associated with contracting 3PLs anywhere in the world even in countries like the UK where a number of the risks mentioned in relation to Nigeria are negligible (Lambert et al., 1999; Boyson et al., 1997; Brown, 2005; Thurston, 1997; Selviaridis et al., 2008; Cooper, 2014; Afzal, 2011; Moore, 1998; Xu & Wang, 2013). Hence, contracting a third-party logistics firm in Nigeria further increases the risks that are already generally associated with outsourcing logistics to a third-party company (Etokudoh et al., 2017; Onyebueke et al., 2019). These barriers partly provide a possible explanation as to the relatively lower practice of third-party logistics in Nigeria.

Evidence also shows that unlike other sectors, which have little evidence of logistics outsourcing, many Oil and Gas corporations (especially international Oil and Gas companies with operating branches in Nigeria) contract third party logistics firms because their logistical needs are much more complex and sophisticated hence requiring the services of experts (Etokudoh et al., 2017, Onyebueke et al., 2019). Also, they contract logistics companies because keeping their logistics in-house will be very expensive due to the high assets and asset management requirment, hence they outsource their logistics to 3PL firms to optimize resources and save costs (Etokudoh et al., 2017).

Also, there are many logistics firms in Nigeria whose customers are SMMEs (Small Medium and Micro Enterprises) across many sectors including the informal sector (Ezenwa et al., 2018). These logistics companies do not necessarily operate on the basis of contract logistics but rather on 'pay as you go' particularly with their micro business customers and those in the informal sector and are hence not formally documented as 3PL activities (Ezenwa et al., 2018). A study by Ndu & Elechi (2014) on third party logistics among SMEs in Nigeria suggested that one of the challenges with logistics outsourcing in Nigeria is inadequate regulation of the industry, leading to a larger informal sector.

In conclusion, the literature does not provide conclusive evidence of the differences in levels of logistics outsourcing between developed economies such as the UK and developing economies such as Nigeria through a comprehensive analysis of the barriers, challenges and problems that exist in these regions. Hence, this paper fills the foregoing gap.

3. RESEARCH WORK: METHOD OF DATA COLLECTION AND ANALYSIS

The research adopted a content analysis method which reviewed data and information about third party logistics in the UK and Nigeria from various sources. This section explains the process through which this research was carried using content analysis.

ABI/INFORM complete database was used as the main database to search for academic papers and reports from newspapers and magazines. Search words such as "UK AND third-party logistics industry" "Nigeria AND third-party logistics industry" "Nigerian 3PL AND market report" "UK 3PL AND market report" "logistics outsourcing AND Nigeria" "logistics outsourcing AND UK". The search generated over 130,918 papers and after inclusion and exclusion criteria were used, 40 papers were selected. The 40 papers included 24 academic journal and conference papers while 16 were online newspapers and magazines. The inclusion criteria included geographical location (Nigeria and UK), date of publication within the last 30 years, relevance to the barriers and challenges of 3PL in Nigeria and the UK and publications in the English language.

Also, GMID (General Market Information Data) and World Bank database were used to obtain insights, statistics, and quantitative data about logistics performance indices in the UK and Nigeria which were included in the analysis. Statista, Armstrong & Associates, Mordor Intelligence, Mintel, Ibis World and ReportLinker websites were also used to obtain insights, quantitative data and statistics about the third-party logistics market in the UK and Nigeria. Also, special industry reports were included in the analysis such as UK logistics report by Freight Transport Association (FTA), UK logistical services report by Mintel, UK third party logistics report by SCALA consulting, Nigeria third party logistics market report and forecast by Mordor Intelligence and Nigeria logistics risks quarterly reports by BMI Research the Fitch Group company.

The research reviewed and analysed all secondary data obtained from the various sources as mentioned above first, in the case of the UK and then Nigeria. After each review the barriers and challenges facing the practice of 3PL in each country were ranked in order of priority according to the frequency of occurrence in the literature and data that was reviewed. The ranking was done by listing the issues in the UK case that was found in the literature in a table and ranking them in the order of 1 as highest and 6 as lowest based on their frequency of appearance in the literature. In the Nigerian case, the issues that were identified in the literature were also listed in a table and ranked in the order of 1 as highest and 15 as lowest based on the frequency of appearance in the literature. The effect of each of these issues were also highlighted in the table (Table 1).

4. RESULTS: RANKING THE CHALLENGES FACING THIRD PARTY LOGISTICS PRACTICES IN THE UK AND NIGERIA

A few challenges have been identified in UK third party logistics from the various reports above. The challenges are retailer's brand image (Cooper, 2014), contract start-up relationship problems and outsourcing relationship issues (SCALA, 2019), labour and driver shortages (Mintel, 2018; FTA, 2019), rising fuel prices (Mintel, 2018; FTA, 2019), road congestion (FTA, 2019) and click and collect (Cooper, 2014). In the Nigerian case, the barriers and challenges are more; up to 15 were identified and ranked below. Table 1 below shows the ranking of the challenges, problems, and barriers to logistics outsourcing in the UK and Nigeria as well as their effects and relevance.

Table 1 Results of comparative content analysis

NO.	**UK- ISSUES**	**FREQUENCY**	**EFFECT**
1.	Driver & labour shortages	2	Causes mild supply chain disruption as reported by FTA (2019)
2.	Rising fuel prices	2	Causes higher costs, reported by FTA (2019)
3	Road congestion	1	Reported by FTA causes mild disruption (2019)
4	Click and collect	1	Presented as a barrier to further logistics outsourcing in the UK retail sector up till 2014 (Cooper, 2014).
5	Brand image	1	Presented as a barrier to further logistics outsourcing in the UK retail sector (Cooper, 2014)
6	Contract start-up relationship problems and outsourcing relationship issues	1	Reported by SCALA (2019) as one of the challenges and problems facing the UK 3PL market
NO	**NIGERIA- ISSUES**	**FREQUENCY**	**EFFECT**

1	Congested road networks and ports	7	Identified by BMI Nigerian logistics risk reports 2014 to 2019 and Etokudoh et al. (2017) as a barrier preventing foreign contract logistics companies from entering the Nigerian market. Disrupts entire supply chain
2	Security issues such as smuggling and robbery	7	Identified by BMI Nigerian logistics risk reports 2014 to 2019 and Etokudoh et al. (2017) as a barrier preventing foreign contract logistics companies from entering the Nigerian market. Disrupts the entire supply chain.
3	High rate of traffic accidents	6	Reported to be one of the barriers preventing foreign contract logistics companies from entering the Nigerian market by BMI Nigerian logistics risk report 2014 to 2019. Disrupts the entire supply chain
4	Poor information flow management/risk and exposure of 3PL's customer secrets to competitors	2	Reported by Etokudoh et al. (2017) and Onyebueke et al. (2019) as a major challenge that 3PL customers experience in Nigeria. This may be one of the barriers to further logistics outsourcing in Nigeria
5	High cost of business operations	1	Reported by Etokudoh et al. (2017) as one of the country specific challenges that Oil and Gas companies experience while outsourcing logistics to 3PLs in Nigeria. It may hypothetically be a barrier from further logistics outsourcing in the Nigerian Oil and Gas sector.
6	Uncertain business environment	1	Reported by Etokudoh et al. (2017) as one of the country specific challenges that Oil and Gas companies experience while outsourcing logistics to 3PLs in Nigeria. This also may be one of the barriers that prevent further logistics outsourcing in the Nigerian Oil and Gas sector.
7	Underdeveloped third party logistics business market	1	Reported by Etokudoh et al. (2017) as one of the country specific challenges that Oil and Gas companies experience while outsourcing logistics to 3PLs in Nigeria.
	Joint venture partnership intervention	1	Reported by Etokudoh et al. (2017) as one of the challenges of logistics outsourcing in Nigeria
9	Differences in organizational cultures	1	Reported by Etokudoh et al. (2017) as challenges 3PL customers generally experience in most countries including Nigeria.
10	Poor vendor or 3PL capability	1	Reported by Etokudoh et al. (2017) as one of the challenges of logistics outsourcing in Nigeria

11	Staff changes/replacement	1	Reported by Etokudoh et al. (2017) as one of the challenges of logistics outsourcing in Nigeria.
12	Corruption/dishonesty	1	Reported by Onyebueke et al. (2019) as a major challenge of outsourcing logistics in Nigeria and may hypothetically be one of the barriers preventing further logistics outsourcing
13	Change in management	1	Reported by Onyebueke et al. (2019) as one of the challenges of logistics outsourcing in Nigeria.
14	Underpayment of staffs by 3PLs and unfavorable working conditions	1	Reported by Onyebueke et al. (2019) as one of the challenges that lead to poor service by 3PLs and may be one of the factors that discourage companies from outsourcing their logistics to 3PLs in Nigeria
15	Inadequate regulations of the Nigerian third party logistics industry	1.	Reported by Ndu & Elechi (2014) as one of the challenges and barriers to logistics outsourcing in Nigeria

5. CONCLUSIONS: COMPARISON BETWEEN NIGERIA AND THE UK

The following conclusions can be drawn from the content analysis.

There are minor and fewer barriers to further logistics outsourcing in the UK (6), which are identified as problems and challenges facing the third-party logistics industry and ranked in Table 1. On the other hand, there are a lot more (15) logistics outsourcing challenges in Nigeria that were identified and ranked and incorporated into Table 1. However, further original primary research is required to evaluate current prevalence of these barriers through the lens of 3PLs and their customers in Nigeria.

The UK third party logistics industry has a well-matured market but this content analysis suggests that Nigeria's 3PL sector is under-developed. Etokudoh et al. (2017) reported that the underdeveloped Nigerian 3PL market remains one of the challenges that 3PL customers in the Oil and Gas sector experienced. However, further original research is required to ascertain the current levels of logistics outsourcing in Nigeria in a wider range of sectors (Etokudoh et al., 2017; Adebambo et al., 2015; Mac-Kingsley & Ihunwo, 2018).
The UK logistics industry continues to grow and is forecasted to grow further despite a few operational and commercial challenges. The Nigerian logistics industry does not show as much potential according to BMI reports due to levels of supply chain risk however, there are still significant growth projections, due to the size of the economy, according to Mordor Intelligence (2020).

In the Nigerian Oil and Gas sector, logistics outsourcing has contributed to efficiency, improved service delivery, cost savings and increased profit making. On the other hand, in the UK, the foregoing results have been achieved as well but evidence shows that they have been achieved in various sectors of the economy and not only in the Oil and Gas sector.

In the UK, however, major 3PL customer satisfaction was reported to be quite low at only 34%. On the other hand, Etokudoh et al. (2017) reported that 76% of 3PL customers that were studied in the Nigerian Oil and Gas sector agreed that logistics outsourcing has been beneficial, though not specifically related to customer satisfaction, and Onyebueke et al. (2019) reported that 80% of 3PL customers that were studied in the Nigerian Oil and Gas sector agreed that logistics outsourcing has been beneficial in terms of cost reduction. However, the majority of these Oil and Gas companies are international companies with operating branches in Nigeria.

Finally, soft factors such as dishonesty and corruption were identified among the barriers to the further use of logistics outsourcing in Nigeria but only business, economic and politically related factors were identified in the UK. Next steps include empirical research into a wider range of sectors and their use and experience of 3PL services in Nigeria.

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SECTION 4 – SUPPLY CHAIN COMPLEXITY & RESILIENCE

UNDERSTANDING UPGRADES-AWARE OVERBOOKING POLICY

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ABSTRACT:

An important challenge faced by airlines is to minimize losses due to involuntary denied boarding that occurs as a result of overbooking. Characterized by narrow profit margins and intense competition, these losses significantly impact revenue as the airline industry is making profits mainly through ancillary services. Seat upgrades, a capacity-constrained ancillary and a technique to mitigate involuntary denied boarding, has helped airlines enhance profits by offering flexibility and risk-pooling benefits. Considering the potential of upgrades, we analyze a profit-maximizing overbooking policy for a single-leg, two-cabin class flight that considers variability in demand, ticket prices, denied boarding costs, and no-show rates for both the classes. We assume that passengers are willing to accept upgrade offers when an upgrade is offered and use a decision-tree based model using realizations to facilitate the analysis. Analytical proofs depict that upgrades increase both the optimal overbooking limits and the net revenue, while numerical example substantiates the proofs. Furthermore, we find that upgrades result in increased denied boarding, which calls for upgrade-aware overbooking policy, i.e., imposing service-level constraints to maintain airlines' reputation.

INTRODUCTION

During 2000–2009, factors such as rising fuel bills, continued liberalization of air services, and increased competition affected airline financial performance (O'Connell and Warnock-Smith, 2013). Post global economic recession, almost 10 billion US$ were the losses accounted by airline carriers in 2009 (IATA, 2011). This led airlines to seek new opportunities to increase revenue by selling ancillaries, which are products that bring additional revenue beyond the sale of tickets by direct sales to passengers, or indirectly as a part of the travel experience (Sorensen, 2011). Ancillaries include commission-based products like advertising, retailing hotels and car-rentals, frequent flyer activities like subscription clubs, loyalty programs, and optional paid services like onboard meal, in flight wi-fi, and upgrades. Initially, pricing ancillaries generated a sense of betrayal and anger among passengers (Tuzovic *et al.*, 2014). However, the value addition it brings to the passengers and additional revenue generated made ancillaries a win-win situation for both the airlines and passengers. Over the years, ancillaries have become a major source of revenue for airlines and its revenue keeps increasing every year (IdeaWorks, 2019). Moreover, without the revenue from ancillaries, airline industry would be making losses (Warnock-Smith, O'Connell and Maleki, 2017). For instance, in 2019, the average net profit of (≈)US$6 per passenger worldwide was because of (≈)US$23 per passenger ancillary revenue (IATA, 2019). Hence, it is important to develop new, efficient ancillary-aware revenue management (RM) systems (Bockelie, 2019). To achieve this, it is imperative to understand the interplay between the traditional revenue management systems and ancillaries. In this paper, our objective is to understand the relationship between seat upgrades as an ancillary and overbooking as a revenue management practice.

Revenue management—the process of maximizing revenues from perishable and fixed capacities—is important to airline industry because of intense competition (Douglas, 2019) and narrow profit margins (IATA, 2019). Smith, Leimkuhler, & Darrow (1992) classify revenue management systems into three major practices: Overbooking (selling more seats than actual capacity), Discount Allocation (segmenting passengers through fares and restrictions) and Traffic Management (managing hubs to provide market mix). Among the three practices, overbooking has huge impact on revenue and is one of the vastly researched areas in RM. This revenue impact is because of the presence of no-shows (Suzuki, 2006), who are people with valid ticket and do not show up at the airport. Formally, overbooking is the process of intentionally selling more seats of a flight than the actual capacity to hedge against cancellations and no-shows. It is one of the traditional RM techniques to improve yield from the available capacity and has improved revenue of the perishable service providers drastically. Though it has long roots compared with other RM practices, the potential downside always exists, i.e., involuntary denied boarding (IDB). For instance, on 9th April 2017, David Dao Duy

Anh was dragged from United Airlines Express Flight 3411 because of overbooking. In response, United Airlines announced the new incentives in the case of IDB. Among all the IDB mitigation techniques, substitution within the flight, especially upgrades, ensures that the passenger reaches his destination on time.

Upgrades have indeed evolved as a successful mitigation technique because of the increased flexibility and satisfaction it offered to airlines and passengers, respectively. However, its potential to salvage the unsold higher class tickets and risk-pooling benefits has made upgrades the capacity utilization-enhancing ancillary. From an ancillary standpoint, upgrades require careful consideration while planning as it is capacity-constrained as well as revenue-enhancing. Furthermore, it has a direct impact on overbooking. Belobaba, Odoni, & Barnhart (2009), Barnhart & Smith (2011), and Phillips (2005) find that upgrades will increase the optimal overbooking limit, and Gallego & Stefanescu (2009) prove that free upgrades can increase revenue. Moreover, due to the revenue potential of upgrades, it is extensively practiced and researched across domains such as car rentals, hotels and semiconductor industries. However, upgrades are double-edged and pose caveats like cannibalization (Y\ilmaz, Pekgün and Ferguson, 2017; Cui, Duenyas and Sahin, 2018) and increased denied boarding that can deter the revenue increase. Hence, it becomes necessary to understand upgrades-aware policies so that the RM systems can ripe the utmost benefits of upgrades.

In this paper, we consider an overbooking problem where the airlines have to decide on the number of reservations they should accept for a scheduled flight. We consider two booking classes (business and economy) and assume that the demand for the economy class can be satisfied by the business class's capacity through upgrades, i.e., passengers can be upgraded from economy to business class. Studies have often ignored business class no-show in models, but Belobaba, Odoni and Barnhart (2009) find that the business-class no-show rate is more than that of the economy class; our model incorporates business-class no-show rate as a parameter. However, economy class overbooking is practiced vastly as business class passengers are of high value, and we follow the same. In reality, the parameters considered in the model like no-show rates, ticket prices, denied boarding costs and demand for both the classes are not deterministic, and we use statistical distributions to model the parameters in a probabilistic way. In addition to the mechanism that considers upgrades, we consider a mechanism in which airlines do not incorporate upgrades while deciding overbooking limit. This latter mechanism helps us highlight not only the benefits of providing upgrades, but also the potential drawbacks that arise while upgrading.

Since we consider free upgrades, we upgrade a passenger if and only if there is no empty seat in economy class cabin to accommodate him. At any instance, the total number of upgrades will be equal to the minimum number of either overbooked passengers or empty seats in business class. Also, we ignore group bookings and assume no-shows are independent of each other. Additionally, we assume that the passenger bears no cost when given an upgrade and incurs no penalty cost in the event of a no-show. Nevertheless, in reality, airlines charge for both upgrades and no-shows. Our models are richly constructed, such that the cost for upgrades and no-shows can be incorporated easily.

The rest of the paper is organized as follows. §2 provides model primitives. Analytical model along with an example and Sensitivity analysis are presented in §3 and §4, respectively. The paper is concluded in §5.

MODEL PRIMITIVES

Description	Economy Class	Business class
Cabin capacity	C_E	C_B
Demand for the class	d_E	d_B
Current overbooking limit	b	-

Number of bookings in the class	$N_E = \min(d_E, C_E + b)$	$N_B = \min(d_B, C_B)$	We
No-show rate of passengers	η_E	η_B	
Show-ups in the class for the given N_E	$(s_E \mid N_E)$	$(s_B \mid N_B)$	
Ticket price of a seat in the class	p_E	p_B	
Denied boarding compensation	h	-	

consider a single-leg flight with two cabin classes (business and economy) and multiple fare classes. With respect to multiple fare classes, it can be regarded as fares paid by passengers as a result of the sophisticated pricing algorithms. Devising pricing is beyond the scope of the paper. Table 1 lists the parameters considered in the models, along with their descriptions.

Table 1: Model Parameters

Let b_U^* and b^* be the optimal booking limits over the given economy class capacity for the mechanism that considers and does not consider upgrades, respectively, and U^* be the optimal number of upgrades that can be provided at the limit b_U^*. Throughout the paper, we use upper-hat symbol (ˆ) to refer the variables associated with a single realization. To differentiate between the two mechanisms, we use the abbreviations UM (Upgrades Mechanism) and NUM (No Upgrades Mechanism) to represent the mechanism that considers and does not consider upgrades, respectively.

MODEL

Our analytical model is based on the decision tree approach given by Phillips (2005). Under the assumption of independent show-ups, Phillips (2005) formulates the risk-based static overbooking model and computes the overbooking limit for NUM for the deterministic case where there is no variability in ticket prices, no-show rates and denied boarding cost. With this model as the baseline case, we formulate a risk-based static overbooking model that incorporates upgrades decision along with variability in parameters while deciding the optimal overbooking limit.

For the risk-based profit-maximizing overbooking problem, the expected net revenue is given by

$$E[R(b)] = E_{p_E,p_B,\eta_E,\eta_B,h}(\widehat{p_E}(\widehat{s_E}|N_E) + \widehat{p_B}(\widehat{s_B}|N_B) - \hat{h}[(\widehat{s_E}|N_E) + (\widehat{s_B}|N_B) - C_E - C_B]^+) \quad (1)$$

In this equation, we have incorporated the upgrades decision and using realizations, we consider the variation in prices, costs, and no-show rates across fare classes. We first discuss the method find the optimal limit for a single realization and present the method to find the optimal limit considering the collection of realizations. As the model is a natural extension to Phillips (2005) model, we can use hill-climbing approach to find the maxima. For the given realization, let us assume $b = 1$, which means we have set the overbooking limit equal to 1. What would happen if $b = b + 1$? There are five possibilities.

1. $d_E < C_E + (b+1)$. There will be no change in this case, as increasing the booking limit will not affect the show-ups, and the net effect is 0.

2. $d_E \geq C_E + (b+1)$ and $\widehat{\eta_E}$. In this case, the $(b+1)^{th}$passenger does not show up; hence the net effect will be 0.

3. $d_E \geq C_E + (b+1), 1 - \widehat{\eta_E}$ and $(\widehat{s_E}|N_E) < C_E$. Since the flight's economy cabin is not fully filled up, the $(b+1)^{th}$ passenger who will show-up can be accommodated. Here, the net effect will be a revenue gain of $\widehat{p_E}$.

4. $d_E \geq C_E + (b+1), 1 - \widehat{\eta_E}, (\widehat{s_E}|N_E) \geq C_E$ and $(\widehat{s_B}|N_B) < C_B$. This is the possibility that we are encountering to solve. Here, the $(b+1)^{th}$passenger cannot be accommodated in economy class as the cabin is filled up completely, but he/she can be upgraded to business class since there are empty seats in the business class. At this point, the revenue gain will be $\widehat{p_E}$.

5. $d_E \geq C_E + (b+1), 1 - \widehat{\eta_E}, (\widehat{s_E}|N_E) \geq C_E$ and $(\widehat{s_B}|N_B) \geq C_B$. In this situation, the $(b+1)^{th}$passenger cannot be accommodated in the flight, and hence he/she has to be denied boarding from the flight. At this moment, the net effect will be $\widehat{p_E} - \hat{h}$, which is a revenue loss situation since $\hat{h} > \widehat{p_E}$.

The possibilities are illustrated via the decision tree, which is presented in Figure 1. The square node portrays the decision: whether to increase from b to $b+1$, the circle node portrays the uncertainty associated with each event, and the leaf node at the end of the branch represents the outcome associated with the decision path.

The change in the profitability from $b \rightarrow b+1$ will be the probability-weighted sum of the quantities in the leaf nodes of the branches. Let $D(b)$ be the net revenue difference between the booking limit b and $b+1$. Then,

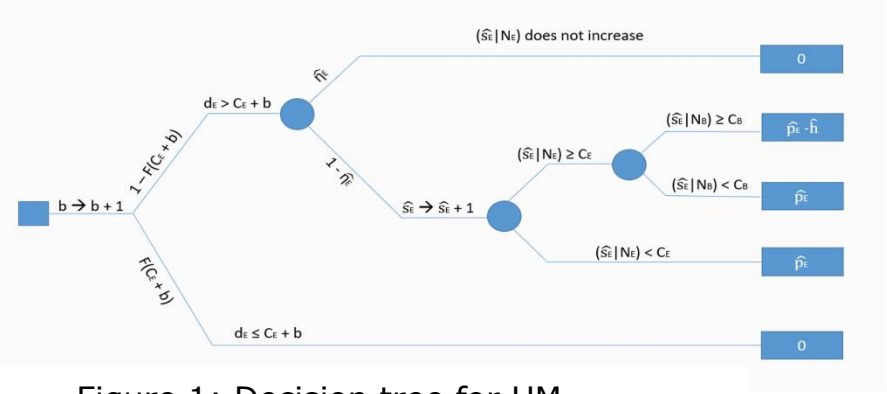

Figure 1: Decision tree for UM

$$D(b) = R(b+1) - R(b)$$

$$= \big(1 - F(C_E + b)\big)(1 - \widehat{\eta_E})[\widehat{p_E} - \hat{h}\,\Pr\big((\widehat{s_E}|N_E) \geq C_E\big)\Pr\big((\widehat{s_B}|N_B) \geq C_B\big)] \quad (2)$$

$$
\begin{aligned}
= F(C_E + b)(0) \\
&+ \left(1 - F(C_E + b)\right)\Big\{\widehat{\eta_E}(0) \\
&+ (1 - \widehat{\eta_E})\Big\{\Pr\left((\widehat{s_E}|N_E) \geq C_E\right)\Big\{\left(\widehat{p_E} - \hat{h}\right)\Pr\left((\widehat{s_B}|N_B) \geq C_B\right) + p_E \Pr\left((\widehat{s_B}|N_B) < C_B\right)\Big\} \\
&+ \widehat{p_E}\Pr\left((\widehat{s_E}|N_E) < C_E\right)\Big\}\Big\}
\end{aligned}
$$

where $\Pr\left((\widehat{s_E}|N_E) \geq C_E\right)$ and $\Pr\left((\widehat{s_B}|N_B) \geq C_B\right)$ are the probabilities that the number of show-ups in a class is greater than the corresponding capacity. It is obvious that $F(C_E + b) \leq 1$ and $1 - \widehat{\eta_E} < 0$. If $F(C_E + b) = 1$, we will not get additional bookings if we increase b to $b + 1$. If $F(C_E + b) < 1$, the impact of the increase in booking limit will depend on the term $\widehat{p_E} - \hat{h}\Pr\left((\widehat{s_E}|N_E) \geq C_E\right)\Pr\left((\widehat{s_B}|N_B) \geq C_B\right)$. As we are using the hill-climb approach, as long as this term is greater (less) than zero, we can increase (decrease) the booking limit. Hence, the optimal booking limit will be at the point, $\widehat{p_E} - \hat{h}\Pr\left((\widehat{s_E}|N_E) \geq C_E\right)\Pr\left((\widehat{s_B}|N_B) \geq C_B\right) = 0$. Thus, the profit-maximizing overbooking limit for the realization will be at the point such that

$$
\Pr\left((\widehat{s_E}|N_E) \geq C_E\right) = \frac{\widehat{p_E}}{\hat{h}\Pr\left((\widehat{s_B}|N_B) \geq C_B\right)} \tag{3}
$$

Since N_E is a function of b, to differentiate the two mechanisms, we use $(\widehat{s_E}|b)$ instead of $(\widehat{s_E}|N_E)$. Rewriting the above expression, we get

$$
\Pr\left((\widehat{s_E}|b_U^*) \geq C_E\right) = \frac{\widehat{p_E}}{\hat{h}\Pr\left((\widehat{s_B}|N_B) \geq C_B\right)} \tag{4}
$$

Similar to Phillips (2005), we derive the profit-maximizing overbooking level for NUM as the point at which

$$
\Pr\left((\widehat{s_E}|b^*) \geq C_E\right) = \frac{\widehat{p_E}}{\hat{h}} \tag{5}
$$

Proposition 1: *The optimal overbooking limit of the mechanism that considers upgrades (UM) will be greater than or equal to that of the mechanism that does not consider upgrades (NUM).*

$$
b_U^* \geq b^* \tag{6}
$$

Owing to the length of paper constraints, the proofs can be attached as supplementary material, if required. At this point, it is not clear whether the increase in booking limit is sufficient enough to make the upgrades desirable (but it turns out to be, see Theorem 1). The incorporation of upgrades will be favorable when they actually enhance the profits. To prove the revenue enhancement of considering upgrades, we require an intermediate result and it is given in Lemma 1.

Lemma 1: *For a given realization, the number of upgrades will always be less than or equal to the difference in show-ups between the two mechanisms.*

$$
\widehat{U^*} = (\widehat{s_E}|b_U^*) - (\widehat{s_E}|b^*) \tag{7}
$$

Using our Lemma 1, it can be shown that $R(b_U^*) \geq R(b^*)$, which is our second proposition.

Proposition 2: *The optimal expected net revenue of the mechanism that considers upgrades (UM) will be greater than or equal to that of the mechanism that does not consider upgrades (NUM).*

$$
E(R(b_U^*)) \geq E(R(b^*)) \tag{8}
$$

Earlier, we stated that an increase in overbooking limit due to upgrades is not sufficient enough to enhance profits. However, it turns out to be the sufficient condition for profit enhancement, which leads to our first theorem.

Theorem 1: *If* $b_U^* \geq b^*$, *then* $E(R(b_U^*)) \geq E(R(b^*))$

The question left to be answered is how to calculate the booking limits. We have two probabilities, $\Pr\left((\widehat{s_E}|b) \geq C_E\right)$ and$\Pr((\widehat{s_B}|N_B) \geq C_B)$, to compute. We directly calculate $\Pr((\widehat{s_B}|N_B) \geq C_B)$ based on the corresponding distributions. For the computation of $\Pr\left((\widehat{s_E}|b) \geq C_E\right)$, as we are using hill climb approach, instead of calculating the probability each time for each booking limit, we can update $\Pr\left((\widehat{s_E}|b+1) \geq C_E\right)$based on $\Pr\left((\widehat{s_E}|b) \geq C_E\right)$, and it is given by (refer Phillips (2005))

$$\Pr\left((\widehat{s_E}|b+1) \geq C_E\right) = \Pr\left((\widehat{s_E}|b) \geq C_E\right) + (1-\widehat{\eta_E})[F(C_E+b)]\Pr\left((\widehat{s_E}|b) = C_E - 1\right) \quad (9)$$

Using this equation, we can start from *b* = 1 and increment *b* by 1 each step at a time. The optimal overbooking limit for the given realization is given by the minimum value of *b* at which the probability value goes above $\widehat{p_E}/\hat{h}$, as we are considering discrete booking limits. Hence, airlines should select the optimal limits based on the following conditions:

$$\widehat{b^*} = \arg min_b\left\{\Pr\left((\widehat{s_E}|b) \geq C_E\right) \geq \widehat{p_E}/\hat{h}\right\} \quad (10)$$

and

$$\widehat{b_U^*} = \arg min_b\left\{\Pr\left((\widehat{s_E}|b) \geq C_E\right)\Pr((\widehat{s_B}|N_B) \geq C_B) \geq \widehat{p_E}/\hat{h}\right\} \quad (11)$$

To find the optimal booking limits for the collection of realizations, we solve for each realization and report the median value as the global optimal booking limit. The reason to report median value instead of mean value is because of the discrete booking limits. We simulate the realizations using R script for making the performance comparison between the two mechanisms, UM and NUM.

Numerical Example

Example 1: To illustrate the example, we need distributions associated with the model parameters. The distributional assumptions are based on the evidences suggested by earlier works. As we could not find the evidence for denied boarding costs, we fit normal distribution as it is likely that the compensation provided will be around a specific number. The values for exogenous parameters and distributions used for illustration along with the references are listed in Table 2. As we are considering overbooking, it is implicitly assumed that the demand is greater than the available seat capacity. Hence, to generate scenarios of higher demand, we use N(130, 20) as the parameter value of d_E.

Description	Economy	Business	Source
Capacity	100	20	
Demand	N(130, 20)	N(30,10)	McGill & van Ryzin (1999)
No-show rate	N(0.2, 0.05)	N(0.25, 0.10)	Popescu, Keskinocak, Johnson, Ladue, & Kasilingam (2006)
Ticket prices	N(1500, 200)	N(6000, 1000)	Kambour (2014); Kumar, Li, & Wang (2018)
Denied boarding cost	N(3000, 500)	-	

Table 2: Parameter values

We illustrate the calculations required to arrive at the optimal limits for both mechanisms for a realization in the Appendix. After simulating 1000 possible realizations, the global optimal limits for the mechanisms UM and NUM is found to be 26 and 33, respectively, proving our Proposition 1. By Theorem 1, we are certain that net revenue will be higher in UM, comparatively. However, we have provided the performance comparison between two mechanisms in Table 3.

Mechanism	Net revenue		Denied boarding		Upgrades	
	Average	90%CI	Average	90% CI	Average	90% CI
UM	231 854	(231260, 232447)	2.096	(1.98, 2.21)	2.14	(2.06, 2.23)
NUM	227 032	(226419, 227646)	1.977	(1.87, 2.08)		

Table 3: Performance comparison of the mechanism

From Table 3, it can be inferred that the net revenue from UM is higher than NUM, which proves our second proposition, $R(b_U^*) \geq R(b^*)$. Also, Table 3 shows that there is an increase in denied boarding while upgrading. This increase is because of accepting more bookings than NUM. Though the difference in denied boardings is small (around 0.1), for an industry with narrow profit margins and intense competition, it becomes necessary to impose service-level constraints that can suppress the unfavorable effect of providing upgrades. A detailed investigation on the importance of service-level constraints is presented in the next section §4.

SENSITIVITY ANALYSIS

Upgrades are becoming more prevalent in the industry, and it is evident from the successes of third party applications like Plusgrade (https://www.plusgrade.com/), Optiontown (https://www.optiontown. com/), and SeatBoost (https://seatboost.com/), which provide upgrade solutions to airlines. Hence, it is of more importance to understand the nuances that impact upgrades. To gather more insights about the upgrades, we investigated the effect of model parameters on upgrades by varying one at a time. We found that, with respect to propositions, the optimal limits increase when economy class ticket price increases or denied boarding cost decreases. Similarly, we found that the change in business class ticket price has no effect on optimal limits and upgrades. Since these findings are well-known, we restrict ourselves to the new insights we got from the sensitivity analysis.

Need for service-level constraints

Similar to a flexible product, upgrades help the airlines to improve revenue by utilizing unsold seats in the higher class cabin. Also, passengers who receive upgrades seem to have increased satisfaction. However, instead of using ad-hoc upgrades, if the airline considers upgrades while deciding the overbooking limit, we prove that upgrades increase the booking limits, which leads to accepting more number of booking requests. This calls for imposing service-level constraints because of the increased denied boarding. Meanwhile, we hypothesized that instead of imposing service-level constraints, can there be a way to retard increased denied boarding? A simple way to reduce denied boarding is to increase denied boarding compensation. Hence, we have taken Example 1 in which we vary the denied boarding compensation from 2000 to 5000 in intervals of 500 and keeping the standard deviation constant at 500.

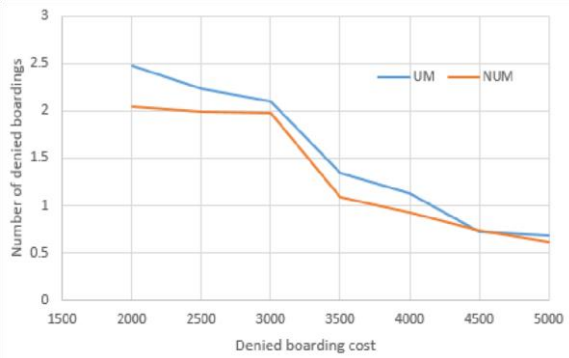

Figure 2: Denied boardings at *h*

It is true that average denied boarding decreases with the increase in denied boarding compensation. However, Figure 2 indicates that the average denied boarding from UM is higher than that of NUM. Hence, increasing denied boarding compensation as a method to reduce average denied boarding between mechanisms falls out. Meanwhile, because of the flat curve around the optimal point and variability in parameters, there are chances that average denied boarding in UM is lower. However, it is recommended to have service-level constraints as the airline industry is highly volatile and operates with narrow profit margins and intense competition.

CONCLUSION

In this paper, we analyze the airline overbooking situation where free upgrades at the time of departure are considered. We assume that passengers are willing to accept upgrade offers when an upgrade is offered. We formulate the profit-maximizing static model to find the optimal overbooking limit and the optimal number of upgrades. Analytical proofs depict that upgrades increase both the optimal overbooking limits and the net revenue, while numerical example substantiates the proofs. Although we used the simulated data to illustrate our analysis, as these data are directly taken from the real-world applications, the model can work for all single-leg settings. However, it cannot be applied to network or multi-leg settings.

Though we have analyzed the airline overbooking-upgrade policy in detail, the results and insights are applicable to service providers who sell perishables. First, whenever there are at least two types of classes (high and low), and as long as the higher class is not overbooked, upgrades can be offered, and it can always be the revenue-enhancing technique. Though this has become a common knowledge, we mentioned it as our analysis regards the knowledge. Second, whenever the potential of upgrades is considered, it is safer to impose service-level constraints that will keep the amount of denied boarding in control, thereby maintaining the reputation of service providers. To put it in simple terms, ad-hoc upgrades are denied boarding mitigation techniques, whereas planned upgrades are revenue-enhancing ancillaries.

For future research, this paper can be extended in multiple directions. Designing an optimal upgrade mechanism that can provide both the optimal price and number of upgrades can be an exciting area to deal with. As our model is static, we ignored the effects of cancellations and arrival patterns. Accounting for dynamics and updating overbooking limits whenever needed can be addressed. The study can also be extended to multiple cabin classes where direct upgrades or cascading or both are allowed.

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A QUALITATIVE SYSTEM DYNAMICS MODEL FOR HUMANITARIAN SUPPLY CHAIN RESILIENCE

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Purpose

Humanitarian supply chains (HSCs) face an unprecedented level of socioeconomic and sociopolitical challenges in addition to the uncertainty of global crises such as the recent COVID-19 pandemic. The purpose of this paper is to review key drivers of humanitarian supply chain resilience along the three main HSCs resilient phases (i.e., readiness, response, recovery), and to propose a system dynamic model that links operational relief resources (e.g., employees, donations, inventory) to drivers of HSC resilience.

Design/methodology/approach

This paper takes a qualitative approach from the system dynamics modeling discipline through a two-phased research design. The first phase is a review of factors affecting HSCs resilience performance under three main HSCs resilient phases. The second phase involves the development of a causal loop model illustrating the interdependencies between performance factors based on a critical literature review. Themes and concepts across qualitative data were synthesized and linked with associated variables to create interdependencies.

Findings

The proposed causal loop model demonstrates the systemic interdependencies and feedback loops between the HSCs resiliency factors that influence HSCs resilience. It is a first step in the development of system dynamics models for the assessment of HSCs resilience.

Originality/value

This paper provides insight into the conceptual understanding of causal relationships of resilience factors in humanitarian relief. It allows for a systemic level of understanding of supply chain resilience in humanitarian operations, which offers insights for practitioners to improve operational performance in presence of unexpected disruptions. The proposed causal loop model provides a catalyst for further research and discussion focusing on resiliency in HSCs.

Research limitations/implications

The model focuses on systemic relationships between resilience factors in humanitarian operations and should serve researchers and practitioners with a preliminary reference model for further development of HSCs resilience evaluation systems. The model is bounded to the qualitative aspects of system dynamics in order to visualize the feedback loop structure related to resilient HSCs.

Practical implications

The causal loop model provides a visual medium by which decision-makers can gain an overall understanding of the links between HSC resilience factors. Therefore, our model facilitates practitioners learning about dynamic complexities and multidirectional relationships between relief chain resilience factors along the three phases of readiness, response and recovery.

Keywords: Resilience, Humanitarian Logistics, Supply Chains, System Dynamics, Causal Loops, Performance Measurement.

INTRODUCTION: RESILIENCE IN HUMANITARIAN SUPPLY CHAINS

Supply chain disruptions are on the rise due to a surge in unexpected political, environmental, and other catastrophic events. The recent and ongoing COVID-19 pandemic has shown vividly the fragility of supply chain systems [1]. Even humanitarian supply chains (HSCs) which are inherently agile have been significantly disrupted due to exposure to multifaceted and compounded vulnerabilities of pre-existing constraints and operational instabilities. Disasters

are inevitable, and developing resilience is the way forward to tackle and minimize unprecedented threats on supply chain systems.

With resilient HSCs designs, the objectives of humanitarian assistance could be achieved on a greater and more reliable level. In essence, improving resilience in humanitarian relief operations contributes to reliable and cost-effective aid delivery. Learning from current and past disruptions and developing contingency planning will strengthen HSCs resilience for future events. Establishing resilient HSCs operational procedures is a key strategy to overcome and control the disruption resulting from large-scale disasters and therefore enhancing the overall HSC performance.

Existing literature on HSCs resilience focuses on the combined impact of agility and resilience on the performance of HSCs [2], implementation of blockchain technology for enhancing HSCs resilience [3], collaboration in relief supply networks [4], analysis of major strategies for resilience in HSCs [5] and development of a redundancy framework for countering the risks inherent in HSCs disruptions [6]. While existing literature provided insights into HSCs resilience approaches in humanitarian relief operations, they are limited in scope and number. The literature indicates is limited to understanding strategies that enable resilience of HSCs and provide limited information on the key drivers of HSC resilience. Furthermore, the literature does not provide directions on how to evaluate the resilience of humanitarian relief operations.

In addition, the examination of causal relationships among different HSCs resilience factors have remained largely unaddressed. Understanding the causal interdependencies among resilience factors will help practitioners in developing strategies towards more resilient HSCs. Hence, motivated by the unexpected challenges and supply chain interruptions caused by the recent COVID-19 pandemic, and given the limited existing scholarly work on resilient HSCs, this paper aims to propose a structured framework for identifying, clustering, modeling, and assessing factors of resilient HSCs. This paper also examines the interdependencies of performance factors of resilient HSCs. It builds on lessons learned from supply chain disruptions to develop a conceptual framework for evaluating and improving supply chain resilience in humanitarian settings.

RESEARCH DESIGN

We designed our research method around two main phases. Phase 1 provides context to the problem and focuses on the formulation of resilient HSCs factors. Phase 2 involves the development of a causal loop model illustrating the interdependencies of performance factors of resilient HSCs.

Phase 1. Identifying and categorizing the resilient factors

Phase 1 identifies and categorizes the resilient HSCs factors. To determine and formulate these constructs, we retrieved and reviewed related articles from major scientific databases using keywords such as "HSCs", "humanitarian logistics", "humanitarian operations", "resilience", "performance measurement", and "performance indicators". We have also reviewed relevant literature with a direct focus on performance measurement of resilient supply chain operations. Based on the collected information, we formulate the most relevant HSCs resilience factors.

Phase 2. Development of a causal loop model for interdependencies of resilient factors.

This phase encompasses the development of a causal relationship model that captures the links among the resilient factors and refines the identified resilient factors in phase 1. We first identified the major causal relations and interdependencies between performance factors found in Phase 1, and then formulated them into a causal loop model. To develop the model, we follow a causal loop diagramming approach [7] to demonstrate the interdependencies using feedback loops.

RESILIENT HSCS PERFORMANCE FACTORS

Table 1 presents the HSCs resilience performance factors we identified through our literature review and categorizes them into the three phases of relief operations (readiness, response, recovery).

*Table 1. HSCs resilience factors**

Phase of relief operations	HSCs resilience dimensions	Performance factors
Readiness	Donations and earmarked funds independency (C_1)	Percentage of program portfolio planned with funds reservations and precommitments with key stakeholders, good knowledge of donor behavior for earmarked and unearmarked funds.
	Volunteer and community resilience management (C_2)	Percentage of trained relief staff and volunteers in basic case management of pandemic cases, Number of staff trained in the use of the UN pool procurement portal, average number of hours spent on volunteers' training.
	Visibility and situation awareness (C_3)	Tracking and monitoring of crowdsourcing using Geographic Information System (GIS), artificial intelligence-based beneficiaries need assessments
	Pre-established and advanced support systems (C_4)	Percentage of prepositioned personal protective equipment (PPEs), face masks, O2 capsule in countries prone to epidemics and pandemics, functioning logistic supply monitoring system for pandemics, number of interactions using Blockchain Technology (BT), Percentage of designated points of entry with screening, isolation facilities and referral system for pandemics.
	Security management (C_5)	Access restriction, personnel security, public-private security partnership, level of personnel protection against kidnapping, maintaining an incident map, level of corruption.
Response	Collaboration and information sharing (C_6)	Country with a functional multi-sectoral, multi-partner coordination mechanism for pandemic preparedness and response, Degree of information sharing and cooperation, degree of supply chain ICT utilization, collaborative need assessment forecasting and risk-sharing.
	Agility (C_7)	Average number of days that material is unable to be supplied, Number of days with stockouts of PPEs, total on-hand stock level in the whole network across all distribution centers and products averaged over the time horizon, lead time ratio, stock-out rate, inventory accurate rate.
	Flexibility (C_8)	Flexibility in customization of relief goods to the beneficiaries' requirements, volume flexibility, distribution flexibility, flexibility in sourcing and order fulfillment, flexibility in change transport modes or routes.
	Leadership (C_9)	Cooperative and intergroup humanitarian leadership style.
Recovery	Knowledge management (C_{10})	Number of social media messages on COVID-19 shared weekly on social media platforms, use of social media and virtual communities of practices, dynamic taxonomies for complex configuration for rapid and accurate knowledge sharing, incorporate local and indigenous knowledge for social recovery resilience, average hours spent on training staff, percentage of staff with certification (or comparable) qualification.

	Contingency planning (C_{11})	Recovery time, reconstruction of the supply chain, supply chain reconfiguration
	Financial efficiency (C_{12})	Stability ratios, capacity (liquidity) ratios, fundraising, expense ratio, total transportation and warehousing costs post-disaster, deviation from project budget, overhead cost.

**Due to space constraints, we were not able to list the references supporting each of these causal relationships, however we will include them in a full paper and can provide the detailed list upon request.*

The next subsection discusses the resilience factors for each phase of relief operations.

iv) Readiness

HSCs resilience performance factors in the readiness phase focus on operational aspects that enable Humanitarian Relief Organizations (HROs) to reduce delays and focus on effective and on-time delivery of relief in case a disaster occurs. Preestablished supply chain mechanism such as prepositioned inventory and equipment, flexible and adaptable supply chain configuration, decentralized fleet of vehicles, and advanced and digital technologies (e.g., 3D printing, drones, big data analytics, and industry 4.0) would significantly enhance the resilience of relief operations [8,9]. The related performance factors are discussed below.

a) Donations and earmarked funds independency

Donation and earmarked funds play a significant role in supporting humanitarian missions, while at the same time posing a pressing constraint and challenge for HROs. Funding not only determines the scope and size of humanitarian operations, but also has a crucial influence on the efficiency and speeds of the operations. It is therefore essential for HROs to be able to engage with donors for creating mutual understanding about the need for flexibility of spending, and developing independence for special donations and earmarked funds. Earlier research has confirmed that flexible use of funds is highly important to HSCs and its performance as highlighted in [10].

b) Volunteers and communities resilience management

Earlier studies have indicated that the highly resilient communities are those that possess an inclusive range of cooperative organizations, often made up of volunteers such as doctors, educators, and religious leaders [11]. Successful community's resilience centers on how a disaster is framed by the community and its leaders and how cooperative the community is in dealing with challenges [11].

c) Visibility and situation awareness

In disasters and unpredictable emergencies, the availability of reliable information for decision-making is critical for saving lives. Situational awareness and data-driven decision-making using Artificial-Intelligence (AI) has become increasingly popular among leading international HROs to develop resilience and flexibility for upcoming disasters [12]. Predictive analytics and AI-based solutions can be applied for humanitarian response to predict the number and type of relief goods when a disaster strike [12].

d) Pre-established and advanced support systems

Due to high level of uncertainty in disaster operations, pre-disasters logistical procedures and mechanism such as prepositioned inventory and equipment significantly enhance the efficiency and effectiveness of relief operations [13]. In addition, the use of advanced and digital technologies (e.g., 3D printing, drones, blockchain, big data analytics, and virtual reality) enables HROs to overcome challenges such as inaccurate needs assessment, inconsistent and outdated information sharing, inability to track resources, thereby increasing the reliability and resilience of the relief operations.

e) Security risk management

Humanitarian operations security management relates to operational and contextual risks, and utilizing effective risk management measures to facilitate safe program delivery [14]. Security management measures relate to access restriction, cyber-security, personnel security,

Standard Operating Procedures (SOPs) to mitigate the threats identified in the risk assessment, security partnership with other NGOs, physical security and evacuation plans.

v) Response

The response is the most critical phase of relief operations. The resilience of HSCs during the response phase concerns mechanisms that enable on-time delivery of relief aid and maintains relevancy to beneficiaries' requirements.

a) Collaboration and information sharing

A collaborative partnership among actors in humanitarian settings helps to anticipate disruptions and manage risks efficiently [13]. Several researchers emphasized supply chain collaboration to be an important factor for HSCs resilience [13]. Collaboration and information sharing minimize the risk of duplication and waste of resources in disaster relief.

b) Flexibility and agility

Flexibility and agility are both essential components of developing supply chain resilience. However, flexibility, agility, and resilience seem to have overlapping definitions and construct as discussed in [15]. Studies have shown that flexibility is a requirement and a foundation to achieve supply chain agility and resilience in humanitarian operations. Performance factors related to flexibility comprise a mix of volume, product, and delivery flexibility. Agility performance factors are related to completeness, reliability, velocity, reactivity, and visibility.

c) Leadership

In the humanitarian sector, leadership plays a significant role in improving relief operational performance [16]. In the context of HSCs resilience, leadership has a direct influence on intra-organizational cooperation, and is as a key enabler of how leadership improves operations. Studies have shown that a strong leadership management style that recognizes distinctive sub-organization relief workers group's behavior enables a cooperative environment within and beyond the humanitarian organizations' boundaries, would enhance cooperation among HROs and in turn facilitates resilience of relief chain operations.

vi) Recovery

Returning to normalcy through reconstruction and restoration of infrastructures after the initial response phase is the prime focus of the recovery phase. It is therefore necessary to explicitly consider the recovery phase during the readiness and response phases, as this will avoid potential problems that may arise after a disaster.

a) Knowledge Management

Knowledge Management (KM) resources (i.e., IT assets and capabilities, cultural KM resource, and human KM resource) have been identified as key enabling factors for supply chain resilience [17]. KM facilitates knowledge sharing and cooperative trust among involved organizations and communities. It facilitates the development of resilient collaborative relationships through inter-organizational learning, post-disaster feedback to develop knowledge about risks, and cost/benefit analysis. As a result, KM increases the reliability and the efficiency of the overall disaster situational awareness.

b) Contingency Planning

Planning includes written contingency plans and procedures to respond to anticipated disaster situations. Standard Operating Procedures (SOPs) that guide staff to mitigate the threats identified in the risk assessment is crucial aspect of contingency planning. Contingency planning should include national and local SOPs for responsibilities, priorities, and key relief operations based on scenarios related to severity and level of disaster damage caused. These SOPs should coordinated with the governmental organizations and authorities, as well as operating them independently.

c) Resilient Financial Efficiency

The impacts of good financial management and efficient funding systems on the resilience and operational performance of HROs have been thoroughly discussed in [10]. It is highly crucial for HROs to maintain steady and stable service provision by ensuring a strong balance of funding sources (i.e., grants, donation, fund-raising activities) [13]. A diverse and stable

funding stream enhances financial resilience and positively affects the survival prospects of the HROs.

THE INTERDEPENDENCIES OF HSCS RESILIENT PERFORMANCE CONSTRUCTS

The HSCs resilience assessment focuses on developing a conceptual causal loop model of the system that identifies interdependencies and the boundaries of performance factors related to HSCs resilience. We propose a causal model of the interdependencies of resilient HSC factors based on literature review. The literature review performed for this study allows us to develop a causal model of the interdependencies of resilient HSC factors.

*Table 2. Examples of causal relationships for resilient HSCs factors in the reference model**

Phase of relief operations	Causal relationship between resilience factors	Direction **+/−**
Readiness	Blockchain Technology (BT) → Swift trust	**+**
	Operational supply chain transparency → Swift trust	**+**
	Blockchain Technology (BT) → Visibility and situation awareness	**+**
	Blockchain Technology (BT) → Financial efficiency	**+**
	Blockchain Technology (BT) → Flexibility	**+**
	Skilled and competent volunteers → Collaboration	**+**
Response	Swift trust → Collaboration	**+**
	Information sharing → Swift Trust	**+**
	Information sharing → Visibility and situation awareness	**+**
	Collaboration → Agility	**+**
	Collaboration → Contingency planning	**+**
	Intra-organizational barriers → Blockchain Technology (BT)	**-**
	Agility → Collaboration	**+**
	Agility → HSCs performance	**+**
Recovery	Knowledge management → HSCs resilience	**+**
	Knowledge management → Visibility and situation awareness	**+**
	Contingency planning → Improved HSCs resilient performance	**+**
	Contingency planning → Collaboration	**+**
	Contingency planning → Knowledge management	**+**
	Resilient financial efficiency → HSCs resilience	**+**
Outcome (resilient HSCs)	HSCs resilience → HSCs performance	**+**
	HSCs agility → HSCs performance	**+**
	Collaboration → HSCs resilience	**+**

**Due to space constraints, we were not able to list the references supporting each of these causal relationships, however we will include them in a full paper and can provide the detailed list upon request.*

The model incorporates variables pertinent to HCSs resilience and aims to summarize key findings from the reviewed literature. The causal loop diagram presented in Figure 1 was developed by identifying key variables affecting the resilience of HSCs (from the literature) and mapping their interdependencies, using the software Vensim. Themes and concepts identified in the literature were synthesized and linked with associated variables to create the interdependencies. We extend the boundaries of the model by identifying links and delays that may exist between variables. The model provides a high-level view of the resilient HSCs. It covers the three phases of the relief operation and demonstrates the causal relationships among variables that drive the resilient HSCs performance.

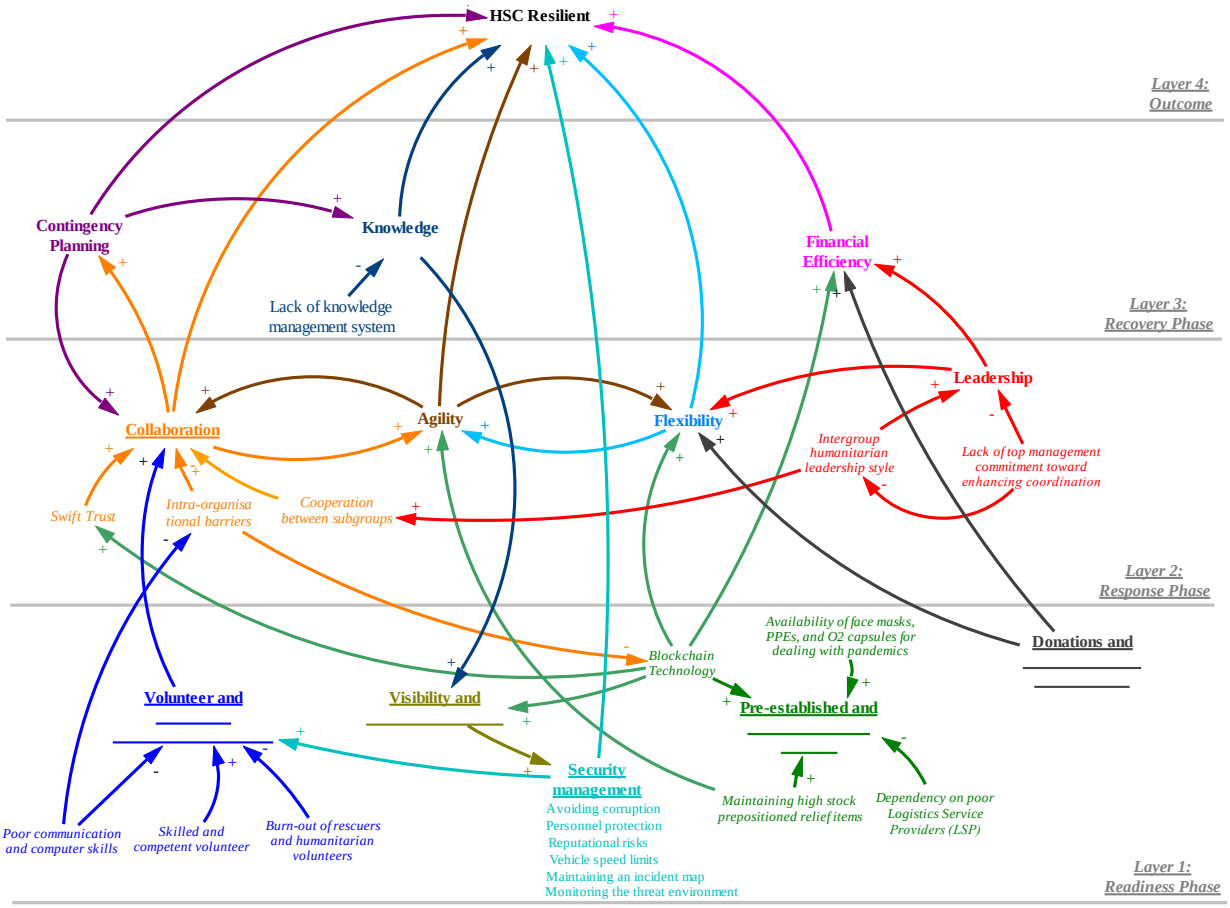

Figure 1. A reference model for interdependencies of resilient HSC factors

DISCUSSION AND CONCLUSIONS

This paper aims to identify key factors of resilience in HSCs and develop a reference model for resilient HSCs. The developed causal loop model demonstrates a number of important interdependencies and feedback loops between resilient HSCs constructs. The proposed model complements existing causal loop models in humanitarian relief, by providing insights about the interrelations between factors of resilience in HSCs.

Our paper has a number of implications for practice and theory. The model presented in this paper contributes to a deeper understanding of resilience factors and their causal interdependencies, which in turn influence the HSCs resilience. These factors are fundamental for preparing for and managing disruptions in a complex and uncertain environment such as humanitarian relief operations. The model provides an initial reference for future theoretical and empirical developments for dynamic modeling and analysis of resilience in disaster relief. In terms of practical implications, the proposed model facilitates practitioners' learning about dynamic complexities and interdependencies between variables involved in HSCs resilience.

The proposed model helps to identify key processes that determine resilient HSCs performance and therefore, supports HROs decision making using a set of key factors of resilience. The factors in the model are presented through a causal loop diagram, which helps to describe the system's structure and behavior in an intuitive way. However, future studies could extend the model and focus on quantitative analysis of an HSC resilient assessment.

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A FRAMEWORK TO BUILD THE RESILIENCE OF SUPPLY CHAIN: A CASE STUDY OF JAVANESE TEA, INDONESIA

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A FRAMEWORK TO BUILD THE RESILIENCE OF SUPPLY CHAIN: A CASE STUDY OF JAVANESE TEA, INDONESIA

Purpose of this paper:
Tea agribusiness in Indonesia considers as labour-intensive business. The existence of tea plantation also fosters the rural development both in economic and social aspect. Eighty percent of tea is produced in Java Island (Directorate General of Estate Crops, 2019). However, several problems regarding inefficiency of tea production centre and imbalance supply and demand in both global and domestic market gives pressure on the sustainability of tea agribusiness and its resilient supply chain. Basic design of a supply chain is a primary factor to determine its vulnerability and resilience (Smit and Wandel, 2006; Waters, 2007). By understanding the vulnerability of each actor in the supply chain, it helps to recognize their ability to efficiently response on the changing condition. Therefore, this study aims to understand the current condition and problems in tea supply chain and to develop the framework to build the resilience and sustainability of tea supply chain.

Design/methodology/approach:
This study is a case study approach focusing on identifying the role of each stakeholder in tea supply chain and determining the further action to build its resilience. The field survey was focused on three regency areas in Central Java Province. The convenience and snowballing sampling were used to gather data and information from respondents. The in-depth interview by using interview guideline was employed to enrich the information about the interaction among all stakeholders in the tea supply chain, the role of each stakeholder and their vulnerability. Total of 175 respondents, i.e. smallholders, middlemen, commercial tea plantations, tea processing unit, packers, traders, and related government officials, were participated. Business process analysis (IDEF0 model) were used in this study to comprehensively describe the current condition and help to develop the improvements action.

Findings:
This paper outlines that severe supply demand conditions in the domestic and global markets contribute greatly to the low benefits perceived by smallholders. The relationship among stakeholder in the Javanese supply chain is also explored through business process analysis. In addition, the livelihood of smallholder is highly depending on the tea farming and tea agribusiness. This condition increases the vulnerability of smallholder toward the changing condition and policy on commercial plantation and tea processing unit. However, the control from a big multinational trader has made the competitiveness of tea agribusiness very rigorous. The production costs in the commercial plantation are quite high with a yield of 20-22%. This paper also reveals the impact of COVID-19 on the resilience of smallholder, middleman and commercial plantation. The integrated framework in this paper describes five factors that should be considered to build the resilience of tea supply chain: vulnerability analysis, assets assessment, collaborative supply chain, control mechanism from government and stakeholder's outcome.

Value:
This paper provides an overview of the Javanese tea current distribution and its contribution to the community development. This paper also highlights the impact of COVID-19 for tea smallholder, middleman, and commercial plantation in general. This paper can be used as an evaluation material for all relevant parties i.e. government, smallholder, middleman and tea

agribusiness to overcome the disruption that might occur and to prepare on building their resilience.

Research limitations/implications:
This research is more focus on upstream supply chain actors including smallholder, middleman, commercial plantation, tea processing unit and government officer. A major limitation in this research is the limited scope in Central Java Province. Further and more analysis might be needed in the future to develop the strategy for Indonesian tea to strengthen the domestic market and compete in the global market.

Practical implications:
The practical contribution of this research is to give understanding about the challenge of Javanese tea in domestic and global market. The integrated framework describes five factors that should be considered to build the resilience of tea supply chain. The finding of this research is also important for practitioner and policy maker to strengthen their role in the tea supply chain.

INTRODUCTION

Tea agribusiness in Indonesia contributes to the vast absorption of labor in the rural area and considers as labor-intensive business. The existence of tea plantation also fosters the rural development both in economic and social aspect. Tea (*Camellia sinensis*) in Indonesia is foreseen as prospective crop because global tea consumption is forecasted to rise by nearly three percent annually over the coming decade. The main tea production center in Indonesia is located in Java Island, where nearly 70% of tea is produced from West Java Province and 10% from Central Java Province. Meanwhile, the smallholder area is accounted for 47% from the total area. The critical role of tea agribusiness on the rural development was revealed through the absorption of around 70,000 labor and support for around 104,000 households or 500,000 people in Java Island (Directorate General of Estate Crops, 2019). However, the weakening in the competitiveness of Javanese tea in global market and the diminishing in the demand of tea on domestic market in recent years has threaten the sustainability of tea agribusiness. The competitiveness of Indonesian black tea is significantly diminishing in the global market in the last decades due to the decreasing of land area for tea plantation, the stagnant production of tea leaves, and the declining of tea export volume for 4-15% per year (Statistics Indonesia, 2020). In the upstream part of supply chain, the increasing trend of land conversion of smallholder area into horticulture commodity indicates the dissatisfaction of smallholder on the income from tea plantation. Several problems regarding inefficiency of tea production center and imbalance supply and demand also give pressure on the continuity of tea agribusiness and its resilient supply chain. Basic design of a supply chain is a primary factor to determine its vulnerability and resilience (Waters, 2007), where a balance between resilience and normal measures of efficiency is required. In this dynamic change and uncertainty of global situation, the understanding of the vulnerability of each actor in the supply chain helps to recognize their ability to efficiently response on the changing condition. Therefore, this study aims to understand the current condition and problems in tea supply chain and to develop the framework to build the resilience and sustainability of tea supply chain.

METHOD AND MATERIALS

This study is a case study approach focusing on identifying the role of each stakeholder in tea supply chain and determining the further action to build its resilience. The primary data were obtained through field survey on October to December 2019 and September to December 2020 primarily on three regency areas in Central Java Province: Batang, Banjarnegara, and Pekalongan regency. The field survey was mainly conducted in Central Java province because the Nucleus Estate and Smallholder (NES) scheme was still existing in those regencies under a commercial plantation called PT Pagilaran. According to Directorate General of Estate Crop (2019), tea agribusiness in Central Java was estimated to employ around 28,234 farmers and absorb 5,862 labors indicating its contribution on the socio-economic development.

The convenience and snowballing sampling were used to gather data and information from respondents, including smallholders, middlemen, commercial plantations, tea processing units

and packers, traders, and related government officials as the detailed number of respondents shown in Table 1.

Table 1. Number of respondents in each tier

Tier	N
Smallholder/farmer	100
Middleman (collector)	39
Commercial plantation: private and state	29
Tea processing unit, trader, tea packer	5
Local government officer	2
Total	175

The in-depth interview by utilizing interview guideline was employed to understand the interaction among all stakeholders in the tea supply chain, the role of each stakeholder and their vulnerability. Furthermore, the demographics information (i.e. gender, farmer status, land status, etc.), farming behavior (i.e. land area, fertilizing and weeding frequency, etc.), and supply and demand activities were explored from smallholders and middlemen. To identify the correlation among those variables, the Spearman correlation was applied. The Kruskal-Wallis test for non-parametric data was also carried out to assess whether there was a statistically significant difference in the variables among group of regency. Meanwhile, the interview with commercial plantations, tea processing units, tea packers and traders aimed to understand the issues and challenge for tea agribusiness, the market trend, and the support from government regarding the trade governance of tea. To comprehend and corroborate the government support on tea agribusiness, the interview with local government officer were also undertaken. In addition, the business process analysis (IDEF0 model) were used in this study to comprehensively describe the key activities of involved stakeholders and help to develop the improvements action.

RESULT FRAMEWORK

To successfully achieve the outcomes of production, stakeholder should recognize their vulnerability in order to be able to give appropriate response for any changing condition.

Business Process Analysis on Javanese Tea

The eight main actors contribute to tea supply chain in Java Island including smallholder, middleman, commercial plantation, tea processing unit (TPU), trader and tea packer, tea auction center, government, and customer (market). Severe supply and demand conditions in the domestic and global markets result in the low benefits for smallholders. The control from a big multinational trader in the domestic market has made the competitiveness of tea agribusiness very rigorous and contribute to low bargaining power.

This study used The Integration Definition for Function (IDEF0) for supporting business process analysis. The IDEF0 (Figure 1) was used to profoundly identify and analyze the key activities and problems among stakeholders in the tea supply chain. The IDEF0 comprises of one box and four arrows to describe the relationship among the entities. The box indicates the stakeholder in the supply chain. The input arrow entering the box indicates the materials and information that drive the activity in the stakeholder. Otherwise the output arrow. The control arrow coming from the top of the box represents the standards, regulations, or requirements to encourage the activity, while the mechanism arrow from the bottom represents the resources used and needed to perform the activity in stakeholder tier. The output in one stakeholder can be as the input or control for other stakeholders. Moreover, the business process analysis (Figure 1) helps to gather and identify the information regarding the vulnerability of smallholder, middleman, and commercial plantation in the current situation. The questions regarding "how much do you depend on tea farming?", "how do you perceive your relationship with the commercial plantation?", and "what incidents, issues or policies from commercial plantation that greatly affect your livelihood?" were also explored to understand the role of tea agribusiness in their area.

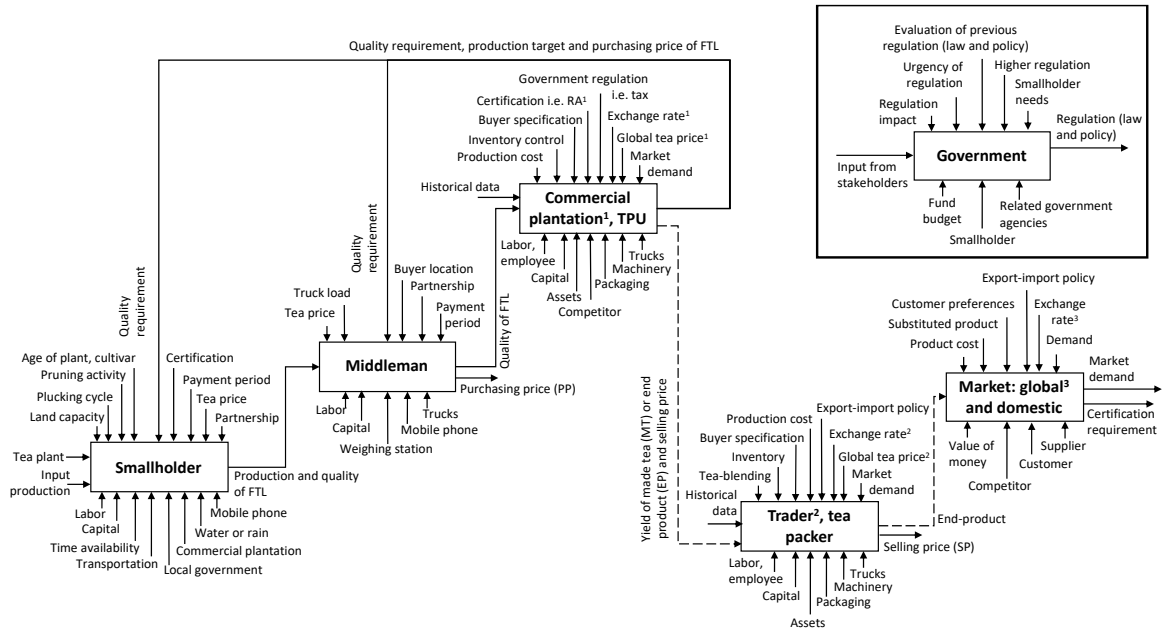

Fig. 1 The business process analysis in Javanese tea supply chain
Source: Primary data (2020)

To produce good quality of made-tea (MT), tea smallholders harvest fresh tea leaves (FTL) from mature tea plant which is four years or older. Pre-harvesting treatments, i.e. weeding, fertilizing and pruning, are executed depending on some control factors. According to statistics analysis result, the educational level of smallholder has no correlation with the weeding and fertilizing frequency. But, the money availability become the most factor influencing them, based on the in-depth interview. Table 2 shows that smallholder undertaken weeding and fertilizing activity two times a year on average due to the limited financial and labor resources. The production of FTL in tea smallholder, shown by solid-line output arrow on Figure 1, depend on the land capacity and productivity, age of plant, cultivar, and plucking cycle. However, the availability and combination level of resources; i.e. labor, capital (money), time, and water; influences the decision of smallholder to perform the pre-harvest activity. Figure 1 also shows that the commercial plantations decide the quality standard of FTL (i.e. soft-plucking of FTL refers to one bud with two leaves) to smallholder and also middleman for gaining good quality of MT.

From the interview, the vulnerabilities of smallholder, middleman and commercial plantation were comprehensively identified. The smallholders rely their vulnerability on the tea production, tea quality and job opportunity to support their livelihood. As tea agribusiness plays a prominent role in rural area, the sustainability of tea agribusiness influences the participation of smallholders and their family on tea farming, smallholder on-farm income and job availability. Meanwhile, the vulnerability of middleman is influenced by the supply and demand of tea in the region, the price of tea leaves and on-time payment. In some cases, the lack of supply from smallholder and delayed payment from commercial plantation has enforced the middleman to take more attempts which accordingly generating more costs. The vulnerability on commercial plantation is indicated by the imbalance supply and demand, the quality of made-tea, and pricing factor. Therefore, each of them should understand their vulnerability to help building their resilience.

Table 2 and Table 3 shows the several demographics information and farming behavior of smallholder in Central Java Province. This statistical analysis was explored to support the findings on the vulnerability factors that has been identified in the smallholder tier. Table 2 shows that 61% of smallholder are fully worked as tea smallholder. The smallholder's tea plantation are mostly their private property which have been provided by government in collaborated with PT Pagilaran since NES scheme on 1980's. Thus, the average of tea plant age in Central Java has been more than 25 years. This plant age that is sufficiently old contribute to the low productivity of tea plant. Furthermore, TRI is a cultivar that has been planted since NES scheme and claimed to be more resistant during drought. Meanwhile, GMB is developed by the Indonesian tea research center since the last 15 years and claimed as high productivity

cultivar. The TRI is the main cultivar for most smallholder (41%) because the replanting of tea requires a large amount of money. However, many smallholders in Pekalongan and Banjarnegara has planted both GMB and TRI cultivar to overcome their vulnerability and build their resilience on changing climatic condition.

Table 2. The demographic information and farming behavior of smallholder in Batang, Pekalongan and Banjarnegara Regency

	Variable		Unit	Regency			Total
				Batang	Pekalongan	Banjarnegara	
			N	42	36	22	100
1	Gender	Male	Percent	81.0	50.0	86.4	71.0
		Female		19.0	50.0	13.6	29.0
2	Farmer status	Full-time	Percent	61.9	52.8	72.7	61.0
		Part-time		38.1	47.2	27.3	39.0
3	Land status	Private	Percent	92.9	94.4	100.0	95.0
		Rent		0.0	0.0	0.0	0.0
		Both		7.1	5.6	0.0	5.0
4	Age of tea plant*		Years	30.2 (8.2)	23.8 (12.1)	25.5 (12.1)	26.9 (10.9)
5	Tea cultivar	GMB	Percent	2.4	27.8	31.8	18.0
		TRI		64.3	22.2	27.3	41.0
		Both		33.3	50.0	40.9	41.0
6	Shading tress	Yes	Percent	69.0	100.0	95.5	86.0
		No		31.0	0.0	4.5	14.0
7	Annual weeding freq.*		Times	2.3 (1.3)	2.4 (0.7)	2.0 (0.4)	2.3 (1.0)
8	Annual fertilizing freq.*		Times	1.9 (0.7)	2.3 (0.9)	2.0 (0.5)	2.1 (0.8)
9	Type of fertilizer	Manure	Percent	14.3	38.9	59.1	33.0
		Urea		45.2	11.1	9.1	25.0
		Combination		40.5	50.0	31.8	42.0
10	Pruning freq.*		Years	4.1 (0.4)	4.1 (0.7)	4.0 (0.0)	4.1 (0.5)
11	Plucking cycles*		Days	47.7 (22.5)	44.0 (20.5)	50.7 (19.1)	47.0 (21.0)
12	On-farm income**		Percent	80.4[a]	72.4[b] (17.8)	79.5[a,b] (18.9)	77.3

	(21.1)	(19.7)

Note: *The value in each regency shows the mean and the value in parenthesis represents its standard deviation. **The significance level of Independent-samples Kruskal-Wallis test is 0.10. The a and b indicate the subset, meaning that the area with similar subset shows a set of means that are not significantly different from each other.

Source: Primary data (2020)

In addition, the major monthly income of smallholder in Central Java depends on tea farming activity, with an average of 77% from their total income (Table 2). The result of Kruskal-Wallis test further reveals the significant difference on the contribution of tea farming for smallholders' income in Batang and Pekalongan regency. Those 80% contribution for smallholders in Batang regency is supported by the higher number of full-time farmers (62%) than that of Pekalongan regency (53%). Moreover, Table 3 shows that merely 12.5% of the total part-time farmers in Batang regency has other jobs outside tea farming, agribusiness and trading. Meanwhile, 64% of part-time farmer in Pekalongan regency work on non-tea field, i.e. non-tea farming, government officers, and other jobs. It particularly indicates that the livelihood of smallholder is highly depend on the tea farming and tea agribusiness. This condition also increases the vulnerability of smallholder toward the changing condition and policy on commercial plantation and tea processing unit.

Table 3. The job classification based on the farmer status

Main or secondary job		Farmer status (%)					
		Batang		Pekalongan		Banjarnegara	
		Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
1	Smallholder	73.1	-	63.2	-	87.4	-
2	Tea agribusiness	7.7	18.7	21.1	11.8	-	-
3	(Tea) Middleman	15.4	62.5	-	23.5	6.3	-
4	Agriculture (non-tea crop)	-	-	-	23.5		16.7
5	Government officer	-	-	-	23.5	6.3	33.3
6	Tea farmer association	-	6.3	-	-	-	33.3
7	Others	3.8	12.5	15.7	17.7	-	16.7
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Primary data (2020)

Figure 1 indicated that the payment period, tea price (purchasing price) and partnership with buyer (i.e. middleman and commercial plantation) contributes on the post-harvest activity of smallholder. In most cases in Central Java, the delayed payment from buyer is the main issue that encouraging smallholder to break the initial agreement and sell their FTL to other buyers. Basically, the smallholders prefer on-time payment rather than higher tea price, because most of tea smallholders greatly depend on the income from tea. Currently the price of FTL in smallholder tier is varied between IDR 1,550 – IDR 2,200 per kg (USD 0.11 – USD 0.16 per kg). The changing and uncertainty condition due to COVID-19 also gives more pressure on them to put minimum effort on pre-harvest activity and sell the FTL to the short-time buyer. However, few smallholders who has robust partnership with commercial plantation are trying to conform to the agreement due to their good historical relationship with the commercial plantation. Smallholder who has secondary job other than tea plantation and good financial management tend to perceive the importance of partnership. Furthermore, similar case is found in the middleman tier as the issue of delayed payment also experienced by the middleman.

Middleman has a greater financial burden than smallholders. It is because a few middlemen give on-cash payment to smallholder but they still endure the late payments from commercial plantations.

Moreover, the production costs in the commercial plantation are quite high with a yield of 20-24%. The low quality of smallholder's FTL has forced tea agribusiness to focus on cost efficiency. The disruption in the commercial plantation is more complex in regards of natural environment, production process, financial, distribution and social partnership. In case of COVID-19, the disruption that happened in both domestic and global market is greatly hindering the supply chain within the company and resulting on the imbalance supply and demand. This imbalance is occurred because the quantity of supply from smallholders is not followed by the quality, thus the products are inadequate to compete in the global market with the competitive prices. In addition, the COVID-19 pandemic also complicates the distribution of products abroad and affects the exchange rate fluctuation, resulting in an increasing of inventory and non-current financial flow at the commercial plantation level.
The commercial plantation in this study consists of private-owned and state-owned plantation company. They typically have their own tea plantation area and build the factory (processing unit) near their plantation and close to the source of FTL supply. Meanwhile, tea processing units (TPU) merely have production unit to process the FTL into MT without having their own tea plantation. They produce and distribute the MT and retail-packaged product according to the market demand.

In addition, the lack of government supports and initiatives was perceived by tea smallholder, middleman, commercial plantation and TPU specifically in Central Java. The government has even made regulations that are burdensome and controversial for tea commercial plantation by setting the value-added tax (VAT) on 10% of the selling price. It is stated in the Regulation of the Minister of Finance, the Republic of Indonesia No. 89/PMK.010/2020. This regulation has an impact on the low selling price of FTL at the smallholder level because most commercial plantations and traders charge this VAT on the purchase price of tea shoots.

An Integrated Framework for Building Resilience of Tea Supply Chain
Building resilience of supply chain should be undertaken by all stakeholders because failure of one stakeholder to deal with their vulnerability will affect the other stakeholders. The integrated framework to build the resilience of tea supply chain under this case study is performed in Figure 2.

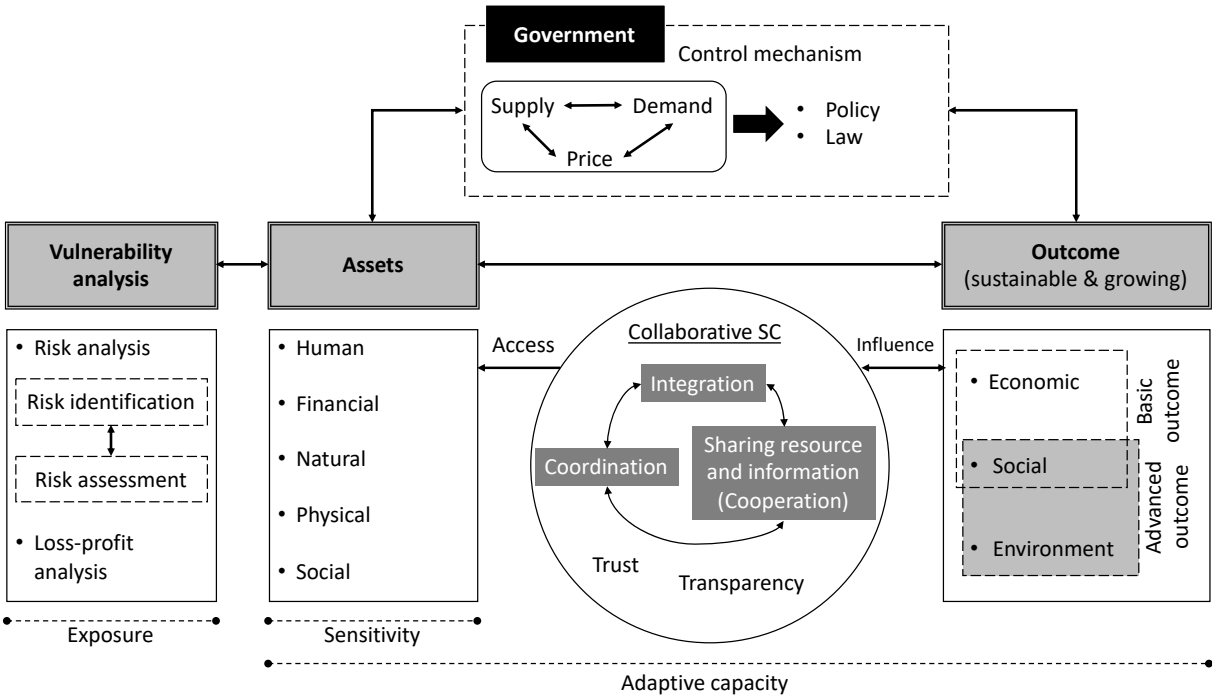

Fig. 2 The conceptual framework to build resilience of supply chain:
A case of Javanese tea supply chain

Source: partly adapted from Department for International Development (1999)

Vulnerability can be foreseen from three elements: exposure to the disruptions, sensitivity to the disruptions, and the capacity of the system or entity to cope with the disruptions (Smith and Wandel, 2006). The combination of those three elements may determine the degree to which an entity, community or stakeholder is vulnerable to the changing conditions. Moreover, assets have relationship with the vulnerability because assets are destroyed and created as a result of vulnerability factor (Department for International Development - DfID, 1999). Vulnerability also does not always have negative connotations and can be expressed as a positive, such as the degree to which a social group can emerge from poverty (Gallopin, 2006). The human, financial, natural, physical and social capital were livelihood assets, according to DfID (1999). This study also confirmed those five main assets and those assets can be assessed in accordance with their sensitivity to the disruptions. The different levels and combinations of assets is then probably the major factor influencing the stakeholder to determine their outcome. The stakeholder's outcomes are expected to grow and be sustainable where a sustainable economy is the basic outcome to be achieved. Thus, when the financial security has been achieved, stakeholders will develop the outcomes for achieving sustainable social and environment.

DISCUSSION AND INTERPRETATION OF FINDINGS

This study reveals that the livelihood of smallholder is highly depend on the tea farming and tea agribusiness (Table 2 and 3). This condition also increases the vulnerability of smallholder toward the changing condition on commercial plantation and tea processing unit. In addition, Table 3 shows the greater number of part-time smallholders in Batang regency having non-tea related jobs than that of Pekalongan. It particularly indicates that the livelihood of smallholder is highly depend on the tea farming and tea agribusiness. This condition also implies that the smallholder in Batang is more vulnerable than that of Pekalongan toward the changing condition and policy on commercial plantation and tea processing unit. Furthermore, the availability of shading trees within tea field is one of the efforts of smallholders to reduce their vulnerability. The decline in tea production during dry season has also encouraged them to seek additional income from horticultural farming or woody tree planting. This has been perceived by smallholder in Pekalongan regency, as 100% of them plant shading tree. The strong engagement among actors in the tea supply chain (i.e. smallholder, middleman, farmer association and commercial plantation) in Pekalongan also contribute on the effort to build the resilience of tea smallholder.

The conceptual framework (Figure 2) on developing resilience supply chain can be adapted by all stakeholders within supply chain. This framework was created based on the development of several previous studies and the finding of this study, and then were adapted to the conditions in the study area. To build the resilience of supply chain, vulnerability analysis should be performed to recognize the disruption that might occurs, including the internal and external environment that influence the stakeholder resilience. The combination of risk analysis and loss-profit analysis can be used to assessed the exposure in each stakeholder. There are many risk standards and guidelines available for the adaption of risk analysis. Further, the sensitivity of stakeholders in tea supply chain to the disruption should be performed through the assessment of assets. This comprehensive analysis on vulnerability, assets and related-outcome may help the stakeholders to response on changing condition and develop the strategies.

To efficiently achieve the outcomes, collaborative supply chain should be involved in the system. However, the collaboration can also either foster or devastate the outcomes of stakeholders. Three degree of collaboration can be considered in tea supply chain: integration, cooperation and coordination (Figure 2). Cooperation is considered to achieve the unity of motivation as the stakeholders might share information, cost, risk, expertise and rewards but completely autonomous from the others (Cao and Zhang, 2013). Coordination is to achieve unity of action (i.e. decision synchronization) due to interdependence, while integration is the unified control (or ownership) of several successive or similar process formerly carried on independently. The degree of collaboration is specific in each case and each stakeholder. Moreover, trust including inter-organizational and inter-personal trust are important antecedents of knowledge sharing between buyers and suppliers in emerging markets (Becerra

et al., 2008; Jiang *et al.*, 2015; Rungsithong and Meyer, 2020). Knowledge sharing depends especially on two aspects of formal institutions: law enforcement and information transparency (Gao *et al.*, 2017). Therefore, to support the collaborative tea supply chain, trust and transparency is also required with a certain level. The government support is also required in this system. Adaptive capacity or the capacity to response the disruption, further, can be done by changing the level or combination of assets and changing the outcomes. For instance, to response on the financial disruption due to COVID-19, the commercial plantation should severely control their financial assets and lessen their outcome to the basic outcome to survive in these conditions. However, a more responsive system of governance will be required to build the resilience of stakeholder in the tea supply chain through the supportive policy and law.

CONCLUSION

This paper provides an overview of the condition of Javanese tea supply chain and its contribution to the community development as well as it can be used as an evaluation material for all relevant parties including government, smallholder, tea agribusiness and customers. The relationship among stakeholder in the Javanese supply chain is also explored through business process analysis. This study found that the livelihood of smallholder is highly depend on the tea farming and tea agribusiness. The changing condition and policy on commercial plantation and tea processing unit tend to increase the vulnerability of smallholder and middleman. Furthermore, the integrated framework is developed and describes the factor that should be considered to build the resilience of tea supply chain. Five broad factors should be considered in this study: vulnerability analysis, assets assessment, collaborative supply chain, control mechanism from government and outcome. However, a major limitation in this research is the limited field survey area in Central Java Province. Further analysis might be needed in the future to develop the strategy for Indonesian tea in order to compete in the global market.

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