RELIABLE QUALITY MODELLING IN URBAN FREIGHT TRANSPORTATION OPERATIONS

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ABSTRACT

Whilst social, economic, environmental and operational variables have often received attention in improving freight performance, there still exists a silent absence of deep-rooted frameworks on constructing reliability models to quantify the quality of surface urban freight transportation operations, particularly road and rail transport. In view of such paucity, the target of this study is to attempt the development of workable models, elaborating the menace of non-value added variables in appraising the severity of incompliance effects in desired quality of freight operations. The introduction of the controllability capability of organizations in overcoming the events and consequences of freight schedule disruptions can strongly assist in streamlining the quality of road freight management. In doing so, a reliable quality priority number is proposed. The considered variables were found capable of improving effectiveness in freight management.

Keywords: Urban Freight Transportation, Reliability models, operations quality, Controllability, freight schedule disruption

1. INTRODUCTION

The increase in demand for safe haulage of goods between production and consumption points in the environment has underscored the need for approaches that can guarantee steadiness in the supply chain management, short of planning to shoulder the detestable consequences of unplanned disruptions (Woodburn, 2019). The urge for maximum freight delivery and a second quest to avoid large scale disruptions in selected surface transportation modes, especially rail and road, seem to have obscured researchers thought pattern to an extent that trivializes the place of quality reliability in supply chain management (SCM). Different pressure issues from key players in freight scheduling, monitoring and implementation resulting from probable supply chain disruptions have been cited as drivers of resilient practices (Solomon et al., 2019; Behnam et al., 2017). Based on this, significant research has evolved on operational and environmental considerations in the bid to provide a smooth running freight management scheme (Kelle et al., 2019; Morvant, 2015; Wang et al., 2014). In this connection, various freight transportation networks based on operational threats and economic impact perspective are well documented (Darayi et al. (2019, Steyn et al., 2012; Slack and Vogt, 2007). The studies concerned with designing for improved adaptive capability to challenges of freight transportation. For example, switching to alternative routes during a specific freight network disruption, which is capable of leading to untimely deliveries at the least. Noting the absence of social performance characteristics found in previous models, Kumar and Anbanandam, (2019) introduce social performance as additional condition for resilient freight sustainability model. Path analysis was employed to validate the proposed approach, taking data from 107 freight transportation records in South Eastern Europe. It is instructive to say that customer satisfaction at a reasonable cost underscores every SCM endeavour. This fact have been acknowledged by notable freight transportation planners (Zeybek, 2018), though the impact is more noticeable in deregulated markets (slack and Vogts, 2007). Government policies and other authorities found in urban areas can affect freight performance and should be mentioned while discussing the integration of value added activities into quality product transfers, attendant management issues and freight delivery life cycle. Past researchers have thoroughly looked into the impact that can be exerted by different authorities, especially in urban freight management as well as urban freight distribution issues (Akgun et al., 2019; Marcucci et al., 2017; Vieira and Fransoo, 2015; Vieira et al., 2015). Accordingly, some contemplated logistic performance concerns that can stem from prevailing government regulations in cities have been significantly analyzed with a view to improving freight operations quality. There seem to be a general agreement of previous presentations that regulation and paucity of collaboration can adversely affect performance in freight operations especially in locations with policy inconsistency. Appropriate institutional reforms where necessary, can provide a good course of action in finding a streamline freight transport regulation that will enhance operation effectiveness. For instance, some freight management studies which analyses various initiatives that can aid public-sector positive reforms in a metropolitan city recently are available (Holguin-Veras et al., 2019; Holguin-Veras et al., 2016). The factors that affect desired quality has undoubtedly been discussed as can been seen from the works cited above. Good environment, economy and social well-being laced with enabling government policies are inalienable for efficient and quality freight operations in most locations of the World. However, the degree of quality of a given freight operation can constitute a very important parameter for Freight transport companies vis-à-vis the service consumers. The concept of quality degree can be expressed in terms of reliability short of effectiveness to allow elaborate consideration of possible Freight operation parameters. In this thinking, the reliability function can be defined as the probability that a given Freight operation variable or process is performed or being performed at the desired quality. The existence of any study which acknowledge quality reliability as an independent or very important parameter in considering the development of resilient reliability measures of quality, in Freight transportation management is not known to the authors. In view of such scarcity, this study propose a new reliable quality management framework for Freight transportation whose thrust is to attempt the proper integration of important non-value added variables in appraising operations of Freight companies. In the framework, Freight transportation disruptions are modelled in terms of severity of delayed delivery effects. A controllability factor is defined, to assess the capability of organizations in overcoming the events and consequences of freight schedule disruptions. In our own opinion, the methodology can be used to streamline suitable reliability variables needed to understand and improve the considered surface Freight transportation quality degree. Additionally, a reliable quality priority number is proposed to further appraise the risk of improper compliance with standard operating conditions of both the freight equipment and other resources that can hinder desired reliability. Although, data used to validate the developed models were taken from a rail and road Freight transport company in South Africa, on conditions of anonymity and confidentiality, it does not preclude possible extensions of the methodology to other Freight transportation modes, though re-parameterization of certain variables may become necessary.

2. RESEARCH METHODOLOGY

This presentation is a proof of concept work on reliability modelling of proper Freight transportation quality quantification. As presented in literature for selection of the most appropriate research design of a study (Dekhandji et al., 2017), a case study research was adopted in an effort to attempt the validation of the models were thought to emerged in the course of the theoretical design. Another reason for following the direction is due to the fact that the considered reliable quality variables were such that the authors had no control over their values. In implementation, ~~extensive~~ literature review of publications bordering on freight operations and management were sourced from well-established repositories, including Elsevier, Inderscience, researchgate and others to properly get acquainted with the trend of discussions in Freight transportation operations. In particular, published articles with good impact factors and appreciable number of citations were mainly used. The case example used was a road and rail Freight transportation company in South Africa. The choice of the company was informed by the ample size and advanced age in comparison with other Freight companies. However, the data collected from the company were obtained on the conditions of anonymity and confidentiality. During the study execution phase, arranged company visits, interviews and investigation of permissible archival documents was implemented. To obtain necessary data relating to how freight transportation and delivery services are practiced as well as the resources involved, expert opinions of experienced staff that have worked in the company beyond ten years were relied upon. There were other interviews arranged with quality assurance and operations managers whose aim was to decide on the most important non-value added variables affecting the quality of freight operations. The number of respondents from Rail Company was twenty against forty interview guides intended and from road companies it was twenty five against fifty interview guides designed. For the opinion survey aspect, five managers were selected from the Rail Company and 10 from the road counterpart. The interest in the sought variables was to provide a good background to constructing useful reliability model for use in quantifying Freight operations quality. The decision to categorize the variables into reliability and quality aspects is actually a descendant of opinion surveys from the company. Through the aforementioned vigorous and lengthy period of brain storming interview sessions, some of the parameters related to challenges in freight quality management from loading points to unloading destinations were established. It was necessary to differentiate the challenges encountered in the freight transportation and delivery from the quality management aspects discovered during the research. The reason for treating the two as isolated cases was to amplify the opportunities of allocating reliabilities based on freight performance information as well as explore potential areas for quality management improvement. Accordingly, six different parameters decided upon the basis of the opinion survey were used to summarize the challenges to freight delivery performance. Relatedly, five quality variables were considered capable of articulating the incompliance (delayed delivery) cases frequently encountered in road and rail freight transportation and delivery operations.

The evident need of a model for deducing the effect of reliable quality degradation and incompliance consequences warranted the use of resultant expected extra cost when a specific variable leads to unaccomplished schedules, customer complaints or dissatisfaction. As agreed with the company, this aspect of data is also treated as strictly confidential. The variable incompliance lead time is calculated as the difference between the time from the report of occurrence of a variable trend deviation and the time of success on returning to normal operation, due to the successful implementation of suitable operational quality control factors. The weight of the reliability and quality variables were decided on the outcome of the foregoing criteria. We cannot overemphasize that opinion survey with experts and archival documents played a major role. Some aspects of analytical hierarchical procedures were invoked to rank the variables. Typical results of such quantification are presented in Table 3. Figure 1 presents the general flow chart of the procedural steps for the development of a reliable quality freight operations framework proposed in the study.

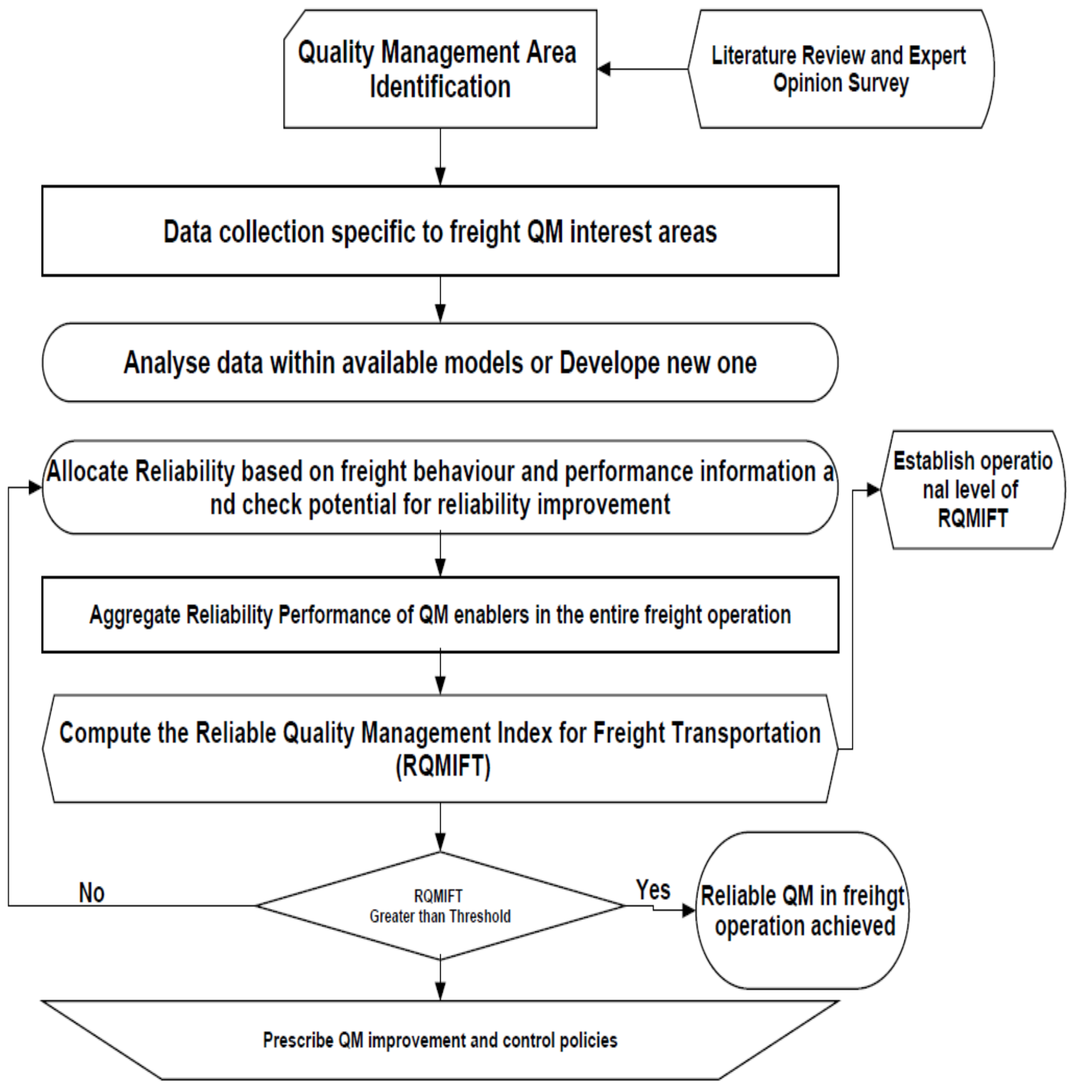

Figure 1. Procedural steps for reliable quality freight operations framework

3. QUALITY MANAGEMENT AREA IDENTIFICATION

Ideally, every area of freight management deserves optimum and reliable quality so that a holistic clean operation devoid of delays can be achieved. The particular area where this study is targeted is enhancement of safe and timely haulage of goods between production and consumption points in road freight management. The real-time transportation facilities covers all types of freight service systems, including carriage by rail, van, truck, or intermodal container. In particular, we develop a methodology for evaluating a reliable quality management index for road freight transportation (RQMIFT), which is based on appraisal of health of the SCM resources and ensuring operability at all times. Good equipment health can guarantee reliability of road freight service systems and improve quality. The study is an attempt to develop templates for evaluating and ensuring reliable quality in management of of road freight transfer resources. The proposed method is against the backdrop that for efficiency and effectiveness of goods haulage, the transportation resources should satisfy some level of operational quality that guarantees reliability before loading, during the journey and unloading of goods at consumption centers. In doing so, a pre-defined reliable quality threshold which is irrespective of cost must be maintained. Elsewhere, service producing systems maintenance has been reported to enjoy cost independent maintenance approach (Ozor and Onyegegbu, 2011) because the system must run to keep the organization's business alive. Moreover, the factors affecting road freight transportation costs are properly documented (Steyn et al., 2012) as presented in Table 1.

Table 1. Needs and drivers influencing freight transport cost on a road network, (Steyn et al., 2012)

	Needs	Pavement Conditions
Infrastructure	Smooth durable safe roads	Lower vehicle operating costs
Vehicles	More economical vehicles	Demands for various types of freight
Freight	Economic movement without damage	Time
Congestion	Minimal congestion	Lowest total cost
Logistics	Smooth route from cradle to grave	Energy costs
Energy	Optimum transport system	Environmental impacts
Environment	Minimal environmental effects	

3.1 Quantification of Reliability Variables

The quantification of the relevant variables contributing to efficient and effective road freight operations can provide a good opportunity of tracing any deviation from expected outcome to its root cause. When this is done, actions can be taken with better assurance of results, rather than spending valuable time in trouble shooting a wide range of possible causes of bottlenecks. The variables can broadly be subdivided into reliability and quality aspects as discussed in what follows.

3.2 Weights of Reliability Variables in Road Freight Transportation and Delivery

In developing a reliable quality management index for freight transportation (RQMIFT), we define a metric called reliable quality priority number (RQPN) to appraise the reliability of an individual reliability variable or the risk of improper compliance with standard operating conditions of the freight equipment and other resources. We assume that the RQPN Index should be able to estimate the state of a reliability variables like maintenance operation conducted on the equipment at any point in time. The strength of the RQPN score has a certain degree of correlation with the quality of update and maintenance operations. That is; the lower the RQPN score, the less reliability freight transportation and operating resources are experiencing and hence the more extra intervention procedures required to improve the quality of operations to avert serious consequences. Recourse to series of root cause of low RQPN can make rapid tackling of iterative problems easier. Towards this direction, the cause of low RQPN or maintenance-induced maintenance problems can be elicited from an array of root cause analytical methods presented in literature (Mahto and Kumar, 2008), so that the RQPN score can be improved. When the appropriate root cause is thus defined, a corresponding quality improvement action (delay removal, use of quality spare parts, correct use of parts/parts replacement, correct installation, bonus, etc) can be implemented to make the individual freight transport resource more reliable. We expect that for specific reliable freight quality mode (Q_R), there exists m freight transportation and delivery variable weights ($vQw_{R_{ij}}$).

Individual schedule of freight transportation and delivery quality can possess specific degree of absenteeism index (AI) on the part of personnel, traffic congestion index (TCI) during actual travel, asset failures index (AFI), infrastructural deficits index (IDI), maintenance optimality index (MOI) and theft index (TI). These are basically pertinent reliability variables related to freight transportation and delivery. Hence high degree of planning on how to efficiently control each variable can amount to an overall reliable quality in the specific freight operation (loading, actual transportation and offloading at destination). For convenience, the last upper case letter (I) can be omitted in each variable during modelling steps, so that the resulting model will be less clumsy. It will be reasonable to define some hierarchical order for prioritizing intervention measures where and when necessary. The lower the hierarchy of reliable quality operation Index, the more acute its weight would be. Also, the more acute a weight is, the more an intervention strategy on the particular variable will constitute a reliable quality to the entire freight maintenance operations. Accordingly, we represent the hierarchy of reliable operation Index weight by its freight transportation and delivery variable weight ($vQw_{R_{ij}}$). Since $vQw_{R_{ij}}$ is the weight of freight transportation and delivery variable which ultimately contributes to the reliability of the individual freight operation, j, then, it follows that the weight of the reliable quality priority number or score signifying the rank of the corresponding variable can be represented by model (1). Table 2 displays the scale used to evaluate the score of reliable quality degradation.

$$vQw_{R_{ij}} = Aw_{ij}\, TCw_{ij}\, AFw_{ij}\, IDw_{ij}\, MOw_{ij}\, TIw_{ij} \quad (1)$$

Table 2. Determination of scale used to evaluate the score of absenteeism index

Linguistic Interpretation	Time span cause criteria	Score
Very low absenteeism record or occurrence	Quality variable can occur in more than 1 year. Very high chance to remedy variables. Point of starting occurrence known.	0.1- 0.2
Low probability of absenteeism occurrence	Quality variable can occur in 4-6 months. High chance to remedy variables. Cause clearly known and understood. Inception point known	0.3- 0.4
Medium probability of absenteeism occurrence	Quality variable can occur every 1-3 months. Medium probability of avoiding quality variables occurrence. Cause Sparingly known. Inception point not clearly known	0.5- 0.6
High possibility of absenteeism occurrence	Quality variable can occur every 1 month. Low methods of avoidance of variables occurrence. Cause and inception hardly understood.	0.7- 0.8
Extremely high probability of absenteeism occurrence	Quality variable present problems all the time. It is impossible to avoid occurrence of absenteeism. Cause not known, requires intensive health care.	0.9-1

3.3 Quality Management Variables

Quality is often used to connote the state of being good and frequently used in marketing materials, short of an integral part of the whole organizations processes. Ensuring rigid compliance and satisfaction of some set of predefined objectives of an organisation stated explicitly or implicitly in order to maintain continuous improvement in processes and designs that produce positive impact. The continuous improvement in freight transportation and delivery, in particular; ought to comply with consistency and reliability with every iteration carefully implemented in order not to foster loss of customer goodwill or interest, missed opportunities due to poor delivery of goods and recalls due to post-delivery presence of design and manufacturing flaws. Al-Ibrahim (2014) document a compendium of past works elaborating the field of quality management and different models suggested by practitioners and theorists in the field. From the author's presentation, pertinent information, specifically; concise definition of quality management was conspicuous. Among the various works, the definition where the two words were explained separately and later merged to produce a better guided direction, is chosen in this study. Accordingly, quality was seen "as pertaining to the degree of excellence of product or service" while management was presented traditionally as "an act, art, or manner of handling, controlling or directing". From the foregoing, quality management in freight transportation and delivery can be taken to mean achieving or surpassing the level of excellence of product haulage by trucks, vans, ships or Aircraft, set by an organisation, through the policy of proper handling of both the system carrying products and the products carried as well as the personnel, with the ultimate aim of customer satisfaction and profitable expansion for the future. In this perspective, people, policies and procedures are combined within an equipment to produce desired effects, which is safe delivery of goods and service resources. While this interaction is not seamless, use of cause effects mechanisms can provide a good means of success measurement and adequately elicit the factors that contribute to negative or positive effects of outcomes. A fishbone diagram first invented by the Japanese quality control expert- Ishikawa, Kaoru (Goodwin and Marden, 2018), and presented in Figure 2 can be employed to evaluate the resource factors pertinent to realizing optimum reliability in the quality of freight operations.

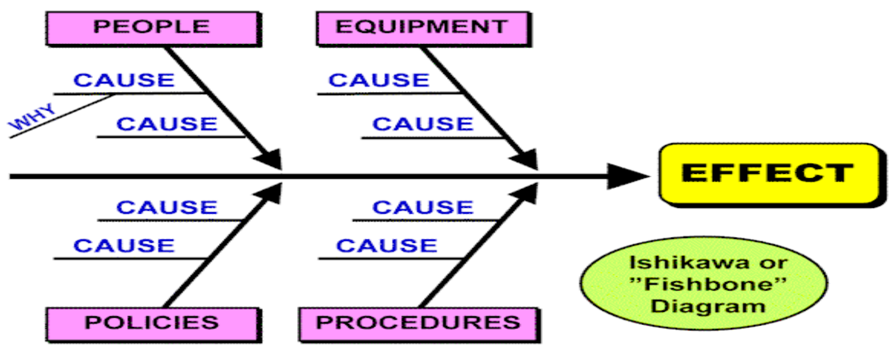

Figure 2. Fishbone Diagram. Source: Silvers (2014)

The variables that can assist in realistic evaluation of reliable quality management in freight operations, particularly during transportation and delivery of products, as abstracted from interviews are listed hereunder.

1. **Resource Failure Status (RFS)**

This variable offers a holistic assessment of the failures in the number of resources required for smooth freight operation. It is concerned with whether or not the necessary factors- products, equipment and personnel are in optimum condition, and if not; what is the readiness level. Failure in the resources can result in failure in the whole freight transportation and delivery effort. The organisation should make realistic efforts to keep the index above or at some level of acceptable value.

2. **Regularity of Maintenance Delivery (RMD)**

It is normally required that the freight resources are maintained regularly as perpetual motion equipment or personnel are not insight. When this is done optimally, there is a manifest positive outcome and reliability in the transportation of products to the desired safety levels and customers specification. The personnel (drivers and guards/assistance) can be maintained regularly through provision of moral boosting incentives and bonuses. The personnel involved in loading and offloading of products should also be rewarded after successful execution of their functions to enhance the chances of improvement. Other aspects of infrastructural and equipment maintenance are discussed under a different variable in this section.

3. **Consignment Delivery Quality (CDQ)**

This variable is intended to monitor the state of the consignment at the point of delivery. It is expected that the quality and quantity at the point of loading should remain the same with what obtains at the destinations. However, some unforeseen circumstances can introduce varying degrees of deviation, making the assumption unrealistic. The amount of variation of the consignment quality is measured using the CDQ.

4. **Scheduled PM Resources (SPMR)**

Preventive maintenance (PM) is the type of maintenance planned in advance to forestall costly and undesirous consequences of unexpected breakdown. During the exercise, operations like cleaning and greasing can be implemented, parts checked for proper alignment while loose tension belts can be tightened. It can include replacement of failed parts and parts thought to fail soon. The frequency of PM is not decided on the rule of the thumb, but embraces special type of modelling techniques (Ozor and Onyegegbu, 2012). This is essentially as too frequent maintenance can lead to maintenance-induced problems just as too distant schedules can allow costly breakdown. Optimum PM Schedules should be arranged for equipment and resources used for freight transportation to raise its reliability and quality of the entire operation.

5. **Scheduled PM Infrastructure (SPMI)**

The scheduled PM for freight transport infrastructure maintenance objective is to maintain the elementary infrastructure in an acceptable reliability and quality level that can facilitate freight and travellers movement by nipping any detectible deterioration before it causes severe damage to life and property. In conducting proper scheduled PM for infrastructure, preservation of prevailing infrastructure assets is ensured in the long term and reliable quality management of freight transfer becomes evident. The World Bank document (2013) successful chronicle the five main reasons for implementation scheduled PM for freight infrastructure as follows: "(i) rehabilitating key transport links, in order to provide better logistics competitiveness; (ii) removing infrastructure bottlenecks to improve regional integration and trade; (iii) modernizing MTOP in its responsibilities in infrastructure management and road safety; and (iv) promoting participation of the private sector in road maintenance, through the promotion of performance-based contracts". Another important part of the SPMI is carrying out checks on traffic lights and signage that can improve road safety as well as enhance drivers' judgement. The SPMI can evaluate the effectiveness and efficiency of freight transportation and delivery infrastructure scheduled maintenance.

3.4 Quality Degradability Estimation

It is required that freight transportation and delivery firms should be able to institute control or inspection techniques that can estimate the scale of ease of detection of the quality Management parameters in the vicinity of the given journey. This basically implies that companies should incorporate strategies to detect out-of-reliable quality incidences in freight transportation and delivery operations. For the particular case of this study, we denote the reliable quality degradability scale presented in Table 2. The hierarchical order for prioritizing intervention measures discussed in session 3.2 is retained. That is; the lower the hierarchy of quality operation Index, the more acute its weight would be. The more acute a weight is, the more an intervention strategy on the particular variable will constitute a reliable quality to the entire freight maintenance operations. However, it should be noted that the degradation or slack in the expected level of a particular quality variable can result in a range of consequences, for either the products being transported, the freight crew (Driver and assistants), if applicable, and the equipment (Truck, Van, Ship, Aircraft e.t.c.) or all. The resultant penalties can come in the form of expanded lead time, consumer dissatisfaction, increased costs cum financial losses, safety concerns and distorted schedules on the part of both company and consumers.

Again, in a holistic approach, estimation of the reliability and quality degradation occurrence in freight transportation and delivery consists of multiple competing parameters, most of which has to be evaluated. For instance, aspects of economics, sustainability, company reputation, environment, ergonomics, safety and so on. In view of the fact of the existence of the above possible multiple competing objectives and consequential negative economical, technological, image or reputational impacts, a multi criteria decision approach is recommended for decision makers interested in fully appraising the severity of reliable quality degradation occurrence in freight transportation and delivery. Even though there is no particular published work satisfying this interest known to the authors, yet all the constitutive parameters can be decomposed in a hierarchical form and a suitable multi-criteria decision making (MCDM) approach implemented. A typical formulation of such method can be found in Sigh and Kulkarni (2013), where a coal based power plant with a large number of equipment was evaluated for criticality. The parameters can easily be re-arranged and applied to the case of reliable quality degradation in freight transportation and delivery.

Table 3. Benchmarks for determining the score of Quality of variables

Linguistic Interpretation	Quality Variable Measure	Score
Very low possibility of variable degradation	Quality variable is certainly complied with confidence	0.1-0.2
Low possibility of quality variable degradation	Very high possibility to detect the compliance of quality variable	0.3-0.4
Medium possibility of quality variable degradation	High possibility to detect the compliance of quality variable.	0.5-0.6
High possibility of quality variable degradation	Medium possibility to detect the compliance with standards using available detection tool	0.7-0.8
Extremely high possibility of quality variable degradation	Quality variable is almost out of standard range. It is impossible to detect the compliance of quality variable using current detection tools	0.9-1.0

3.5 Reliable Quality Degradation Effect Controllability Score

As the resources for road freight transportation and delivery are deployed to service, occurrence of degradation and deviations from original standards of the constitutive variables can occur at any time. Definitely, occurrence of any or all of the listed negative effects discussed earlier can affect firm operations negatively as well. Expectedly, the severity of any deviation or degradation will be mild in cases where the control strategies of the affected variable is efficient. In line with this fact, the criticality of degradation consequences is reversible with availability of pre-determined level of operational reliable quality measure and the controllability readiness of the corresponding variable(s). The probability of freight transportation operational variable controllability can be denoted by PFW_k. It is possible to record many reliable quality degradability or incompliance variable within a given period of freight transportation and delivery, 0 to t, say. The rate of occurrence of variable incompliance can be added and formulated as the ratio of the occurrence of a specific variable incompliance over the total of variables incompliance recorded. For example, if OV_r denotes the occurrence rate of variable k within an interval (0 to t), then the score of the occurrence rate of reliable quality degradation or incompliance of variable mode i can be determined from equation (2).

$$OV_{r_i} = \frac{OV_{r_i}}{\sum_{i=1}^{i=n} OV_{r_i}} \qquad (2)$$

$i = 1,2,3, \cdots, n$

n= number of variable modes

3.6 Acceptable Level of Operational Reliable Quality in Freight Management

To properly explain the controllability measure in this presentation, we define the operational control factor as any factor whose value determines the controllability of reliable quality degradation effects. In other words, the controllability measure has a significant correlation with operational control factors. It is referred to as acceptable level of operational reliable quality in this study. When the index is below this datum, the freight transportation and delivery expectations cannot be guaranteed, but the reverse will be the case otherwise. In a global scale, the determination of operational control factors can be estimated on the basis of preliminary tests, historical experiences from proficient freight transportation and delivery operations as well as decision makers' judgement. While organisations make substantial investment in mitigating efforts of negative impact of operational quality variables degradation and incompliance issues, the reliable quality, organizational and financial competency attributes can all constitute the basis for determination of the value of operational control level. Additional organizational attributes like capability of facilities, competency of administrative control and accompanying supporting data can equally be explored for use as control variable.

Continuing with the logic that the severity of a variable degradation correlates almost directly with the rank of incompliance causes, the probability of degradation occurrence and that of combating it with organization's capability to control its effects; the severity of degradation occurrence can be given as

$$\text{RQPN}_w = \frac{Wq_{w_c} OV_r \, DV_d P_k RQ_w}{POC_n} \qquad (2)$$

While the symbols are identified by the following significances

RQPN_w= Occurrence rate of variable mode n;
Wq_{w_c} = Weight of reliability quality degradation cause of variable mode n;
OV_r = Occurrence rate of variable n
DV_d = The extent at which the degradability variable mode k can be diagnosed;
P_k = Penalty due to the occurrence of reliable quality degradation mode n;
RQ_w = Weight of the reliable quality variable mode n;
POC_k = Level of probability to which the organizations operational control capability can reverse the occurrence of reliable quality mode n;
$n = 1,2,3, \ldots$

4. DATA ANALYSIS AND DISCUSSION

This work is basically a proof of concept study aimed at supporting the realization of reliable quality freight transportation and delivery operation variables prioritization and sustenance.

Descriptive phenomenology analysis (Creswell, 2008) is mainly employed in the presentation, as the major objective of the research is to display important configuration of the development of a reliable freight quality management system that can enhance operational performance. In the study, it was interesting to see the emergence of a new model for accessing the severity of reliable quality freight delivery operation variables incompliance or degradation in an attempt to contribute to the discussions in quality freight management references in Operations and Supply Chain discipline. The authors had a palpable ignorance of evidence of previous works that borders on hierarchy of root causes of unaccomplished freight delivery schedules. The inclusion of workable models, multiple reliability and quality variables in appraising the severity of incompliance effects, as well as the introduction of controllability capability of organizations in overcoming the occurrence and consequences of freight schedule disruptions can strongly assist in streamlining road freight management. Concerning the inherent benefits, this study contributions can be profitable for practical and theoretical intent and purpose. Firstly, the methodology suggests helpful components of freight transportation and delivery issues not contemplated *a-pri-ori* in previous freight management references. Some of these components include reliable quality management factors and respective weightings, quality degradation estimation, reliable quality degradation effect controllability factor and acceptable level of operational reliable quality model. The factors so introduced, in our own considered opinion, is valid in assessment of delayed freight delivery causes, consequences and control interventions. On the other hand, the paper discuss the deployment of multi-criterion methodologies in evaluating the severity of quality degradability estimation effects which creates an enabling environment to adapt a real life case that can allow decision makers embolden the knowledge of the consequences of their decision. Finally, the study develops a framework of reliable quality management in freight transportation and delivery operations in which to our knowledge at the time of conducting the research, is still vacant in literature.

For simplicity reasons, that is; to avoid very small number figures while multiplying the models and variables' components, the RQPN can be transformed by multiplying uniformly with large numbers, if need be. The result can then be displayed in Tables and Figures. Referring to this study case example, values of the weights of the respective reliability and quality management parameters were deduced through rigorous analysis of the information and opinion surveys conducted within the selected freight company. Results of these analysis are depicted in Figures 3 and 4. Upon in-depth consideration of all the factors, the operational level of reliability components in the neighbourhood of 0.25 was established. This level can guarantee sustained freight operations. The quality level of 0.4 was considered very reasonable to make for improved performance in the quality components of the freight operations. It follows that the studied case company is close to reliable freight performance, considering figure 3. It can be seen that the absenteeism index is less than 20% just as the maintenance optimality index. Yet the company can put more effort in curbing unwarranted excuses as well as review aspects of the maintenance culture that results in delays and sub-optimal maintenance. The AFI, IDI and TI are simply so close to the acceptable operational line. There is need to incorporate improvement programmes aimed at stabilizing the parameters. The TCI is in a comfortable zone. Hence, current efforts should be directed to its sustenance. The quality management graph of Figure 4 show that the parameters RMD , CDQ, and SPMR are well above established operational levels. The RFS experienced a slight drop whereas SMPI is well below operational quality level. Concerted effort can therefore be made to raise the scheduled maintenance interventions being carried out on the infrastructure for sustained quality freight operations. Notwithstanding the conspicuous achievements of the study, the entire research effort and its propositions are not without some notable limitations. In the first instance, provisional to the context of its application, difference freight management settings can offer different delivery delay modes. Ultimately, this can lead to varying reliable quality priority numbers and different variables as well as diverse incompliance or degradation modes.

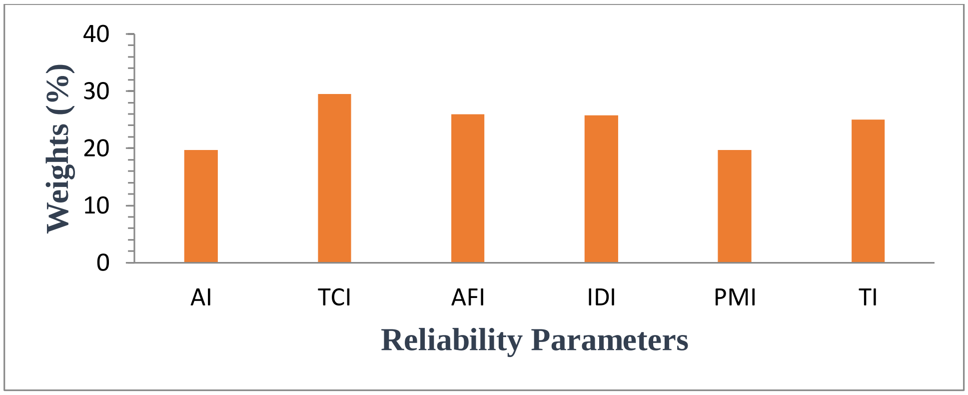

Figure 3. Weights of Reliability Parameters

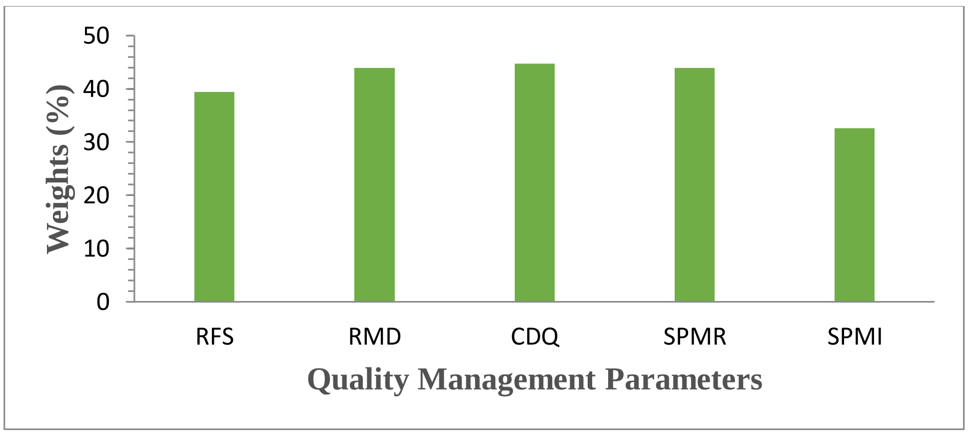

Figure 4. Weight of Quality Management Parameters

5. CONCLUSION

In this paper, a framework for achieving reliable quality management in road freight transportation and delivery is proposed. The methodological procedures present new components for thoroughly evaluating degradation and incompliance modes in freight delivery schedules using a proof of concept technique. The result show that improvement, stability and sustainability can be achieved in performance of freight companies through the method described in the research. The probability of degradation effects controllability aspect was discussed which can assist to measure organizations' controllability capability over some inevitable incompliance effect incidences. The procedurals steps which was significantly explained can provide Managers in Freight transportation and delivery with many reliable and qualitative criteria on the consequences of delayed freight delivery and mitigation possibilities. Though, part of the original intent was to abridge the noticed gap in modelling reliable quality management of freight transportation and delivery literature, the research eventually opened further research opportunities. In particular, the cause of reliable quality degradation and delays in scheduled delivery date and time can lead to contradictions amidst multiple competing variables and solutions, in certain situations. To resolve this condition, this study can be extended by exploration of evolutionary algorithms for deciding on control actions for the specific case idealised. Another future research effort can equally explore the opportunity of modelling freight performances in different operating regimes.

6. ACKNOWLEDGEMENT

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