Modelling the supply chain perception gaps

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Abstract This study applies the research of perception gap analysis to supply chain integration and develops a generic model, the 3-Level Gaps Model, with the goal of contributing to harmonization and integration in the supply chain. The model suggests that significant perception gaps may exist among supply chain members with regards to the importance of different performance criteria. The concept of the model is conceived through an empirical and inductive approach, com-bining the research discipline of supply chain relationship and perception gap analysis. First hand data has been collected through a survey across a key buyer in the motor insurance industry and its eight suppliers. Rigorous statistical analysis testified the research hypotheses, which in turn verified the validity and relevance of the developed 3-Level Gaps Model. The research reveals the significant existence of supply chain perception gaps at all three levels as defined, which could be the root causes to underperformed supply chain.

Keywords*:* 3-Level Gaps Model; perception gaps; supply chain management; supply chain integration; supplier evaluation.

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1. Introduction

Over the last two decades, supply chain integration (SCI) has become increasingly important across all industrial sectors [1]. However, delivering and sustaining it in a real-world supply chain turns out to be a serious management challenge [2,3]. Integration across the supply chain has also been seen as the driver towards better performance and a source of competitive advantage [4-7]. Nevertheless, increased supply chain complexity, market dynamics, and technological disruptiveness have made it a challenging endeavour [8].

One of the major impediments in SCI is the *perception gap* – predominantly the underlying differences of views and expectations between supplier and buyer towards key performance criteria. Perception gap is not immediately visible and has not been measured so far in the literature. *Perception gap* exists where different parties see the world differently [9]. In the context of supply chain management (SCM), it often results in and is commonly exhibited as the expectations differences. It represents the differences of tacit knowledge between different people or groups of people on the same object. The persistent presence of the perception gaps can severely undermine the business relationships and the products/services delivery standards of a supply chain. Since perception gaps between supplier(s) and buyer(s) are often the root cause to many problems, they must be made explicitly visible and subject to the management scrutiny [10].

The fundamental research problem therefore can be identified as follows: We know a notional and plausible existence of perception gaps arising within a supply chain but do not necessarily know the precise degree of severity of its existence, nor are we clear about the different types of the gaps. Furthermore, not knowing precisely the where-about of its existence has made it impossible for supply chain managers to take effective measures to mitigate the potential negative impacts of the perception gap. This becomes a legitimate problem because perception gap self-evidently relates to supply chain performance and especially the level of cohesiveness and integration. Performance measurement is an essential concept in SCM, and is used not only for supplier evaluation, but also for supplier selection [11-14]. However, there does not exist a research that frames and measures the perception gap regarding the importance of the various performance criteria.

Perception gap and its behaviour are not new concepts, but their implications with regards to understanding the supply chain relationships and SCI have not been thoroughly explored [15,16]. Even strategic information exchange, which is much simpler than SCI, can enhance supply chain performance [17]. Communication of perception gaps should be part of strategic

information exchange, and one would expect better supply chain performance when perception gaps are eliminated. Slack *et al*. [9] identified the operational principle that "unsatisfactory supplier relationships can be caused by *requirements* and *fulfilment perception gaps*". The main model describing the differing perceptions across the dyadic supply chain, as described by Slack *et al.* [9], is illustrated in Figure 1. Perceptions can play not only a direct, but also an indirect role on the performance of the supply chains, through the attitudes and actions that the managers take based on their perceptions. Ho *et al.* [18] illustrate this phenomenon for the case of SCM system adoption in enterprises.

It might seem that the model can be applied to all the dyadic links in a supply chain, with specific focus on the requirements perception gaps and the fulfilment perception gaps. Yet, fundamental research questions (RQ) still remain to be answered:

RQ1. Could significant levels of perception gaps exist in supply chains?

RQ2. Would it be helpful to identify them theoretically with a model, in order to reveal the root causes of the problems in SCM?

RQ3. Could the understanding and the measurement of the perception gaps provide guidance to the strategic supply chain performance improvement?

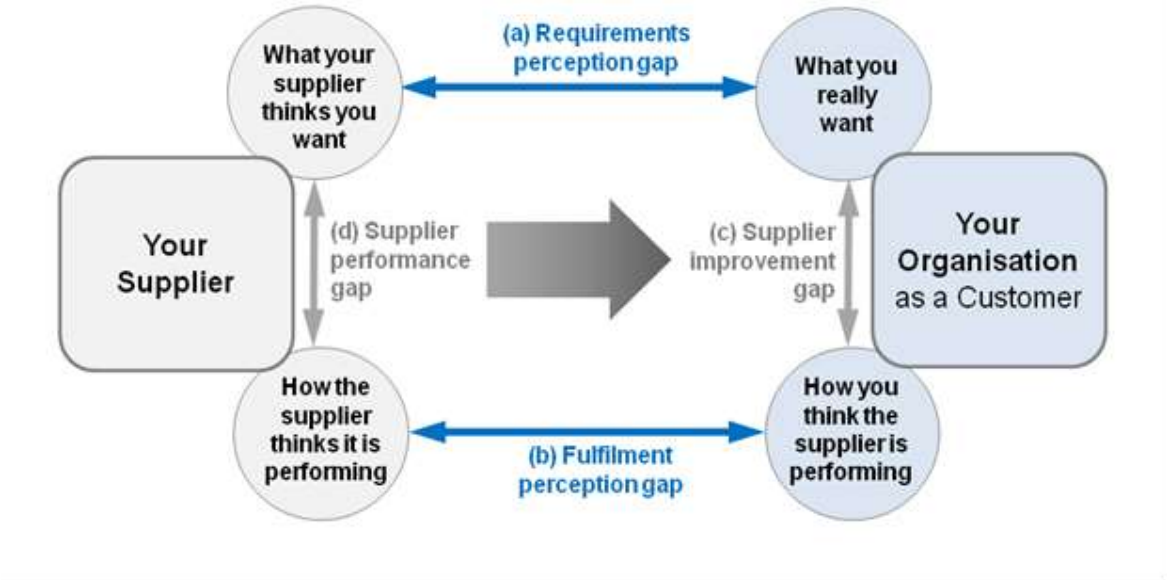

Fig. 1 Supplier perception gaps (Slack *et al.*, 2009)

In this paper, we carry out thorough statistical hypothesis testing using real-world case data, for addressing research question RQ1. Yet, before that, we present an extensive exploratory discussion, engaging relevant body of literatures, to propose a conceptual framework that integrates the supply chain perception gaps into the **3-Level Gaps Model,** which in effect addresses RQ2. RQ3 will be left for a more extrapolated discussion at the end of the paper. Part of RQ3 is meant to be provocative and may not be fully answered, and thus may have to be left for future research.

The key objective of this paper, therefore, is to ascertain the significance of perception gaps from a SCM perspective and to develop a conceptual model. The developed model will frame the three types of perception gaps and their relevance in the context of improving SCI.

The remainder of the paper is organized as follows: Section 2 presents a literature review on supply chain relationships, integration and provides theoretical background on perception and expectation. Section 3 introduces the 3-Level Gaps Model and its hypotheses. Section 4 explains how the data were collected and how the statistical methods were employed for the data analysis regarding a major Motor-Insurer company. Section 5 presents further analysis, results, and the managerial implications. Finally, Section 6 summarizes the key conclusions and outlines further work.

2. Literature review

The purpose of the literature review here is to establish the relevance of the concept of perception gaps and the highly concerned SCM issues including relationships, integration, and performance. This will then lead to a better understanding of why it is necessary to have a framework of perception gaps before any of those issues can be addressed more effectively. Furthermore, the review also shows a gap in the literature where the topic could be more extensively discussed in the context of SCM.

Starting with the issue of SCI, over the last few decades the importance of supply relationships has been discussed extensively amongst the academics and practitioners alike. Those discussions have led to converged findings on the critical success factors for developing an appropriate portfolio of supply relationships [19-21]. More in-depth explorations were also seen to be carried out on the interaction of those factors [22-25]. Somewhat conclusively, those researches have all pointed out the significant implication of people's *anticipation* and *expectation* to the effectiveness of SCI. The issues of perception

gaps between the suppliers and buyer as a negative factor has been highlighted in some of the mentioned studies, but only implicitly.

The nature of the supplier buyer relationship plays a pivotal role in SCI. Some researchers [26,27] further underpin the strategic decision-making role of relationship in SCI in terms of supply chain design and configuration. Other researchers discuss the critical role that supply relations played in obtaining competitive advantage in today's fast changing business environment [28,29].

As a broad development trend, it can be observed that over the years, the main focus of relationship management has shifted away from predominantly discrete transaction-based exchanges towards continuous relationship-based exchanges [30,31]. This trend was also seen to be alongside with the shift from operational to process-oriented SCI. However, buyer-supplier relationship development is not the ultimate objective for SCI. It is only the *means* to achieve better SCI and better supply chain performance. Lee [32] suggests three primary dimensions of SCI: organisational relationship linkages, information integration, and co-ordination & resource sharing. Handfield and Nicols [33] define the three principal elements of SCI as relationship management, information systems, and management of material flows. Van Donk and van der Vaart [34] also propose similar concepts of SCI. Thus, relationship management delivers the implementation-end of SCI, whilst SCI is the extent that organisations are integrated with their supply chain [35]. To this end, it is safe to observe that the issues of perception gaps in the context of SCM are deeply intertwined in the concept and practice of SCI and supply chain relationship management.

Given the increasing trend of global supply chain competition, integration is regarded as one of the key prerequisites for sustained supply chain success [36,37]. The underlying concept of SCI originated from a system perspective, in which the optimised whole will always have more value-adding than any sub-systems. SCI can be characterised by cooperation, collaboration, information sharing, trust, partnerships, joint new product introduction, process alignment, as well as other traits [38]. Benefits and advantages of integration have long been demonstrated via its impact on supply chain performance [39,40,41,42]. It is therefore also logical to make extrapolated causal links from perception gaps to supply chain performances, although how significant this causal link might be is a very much a research agenda. Thus understanding perception gaps is important due to its potential impact on supply chain performance.

Customer behaviour theories (including *relationship marketing*, *personalized marketing*, *customer retention*) consistently state that buyer's psychological factors, such as individual

perception, expectation, motivation, attitude, and belief play pivotal role in determining the level of satisfaction, preferences and the associated consequential behaviours such as purchasing decisions and loyalty [43,44]. *Customer behaviour* theories also stipulate that understanding and cultivating the right customer expectation is the centre piece for achieving customer satisfaction and effective supply chain intermediation [45,46,47]. One can understand that the buyer's perception is based on its evaluation of the product or service received. When perceived performances are lower than expectations, it is a sign of poor service or product quality by the suppliers; and the reverse indicates good quality and service standard. The perception or the perceived quality is an overall judgment on the supplied products or services. However, prior to their service experience, buyers create expectations against which the supplier's performance is evaluated [48]. Consequently, the images of perception involves the subjective responses of people and are therefore highly likely inconsistent with the reality or with each other [49]. All these observations from the literature serve as the empirical evidences of the undeniable existence of "perception gaps" and their implications to SCI.

Customer perceptions and expectations are central to supply relationship. Studies by Oliver & DeSarbo [50] and Andreassen [51] found a theoretical support for the effects of perception on the customer satisfaction or dissatisfaction. They stated that the perception-based expectations cause an *assimilation effect*, while discrepancy between perception and reality results in a *contrast effect*. According to the *assimilation theory*, people tend to respond according to their expectations because they are reluctant to admit wide discrepancies [52].

Our literature review clearly shows that some limited theories on perception gaps may have already been documented. Yet, studies in how do they affect the SCM and supply chain performance remain scarce. This vacuum in the literature is one of the main motivations for the research.

3. Three-Level Gaps Model

Based on the literature review in the field of perception gaps and the general knowledge of SCM, we take a view that the perception gaps in the supply chain can occur at three different levels. At each level the perception gaps are formed from very different factors and can have very different managerial implications. To theorize the perception gaps and their managerial implications, we frame and propose a conceptual model—"3-Level Gaps Model" as shown in Figure 2. The model illustrates the positions and the inter-relations of all possible perception gaps at the three levels between any two tiers of a supply chain. The model as a conceived

idea will only be accepted methodologically as a meaningful contribution to the body of knowledge if it is tested and verified using appropriate methods. Thus, as a research approach, we propose three hypotheses regarding each of the specific perception gaps, and then apply the appropriate statistical methods to test them. The data collection described in Section 4 and data analysis in Section 5 are intended to show that the perception gaps not only do exist at all three different levels in the Motor-Insurer's supply chain case, but also with a convincing statistical significance.

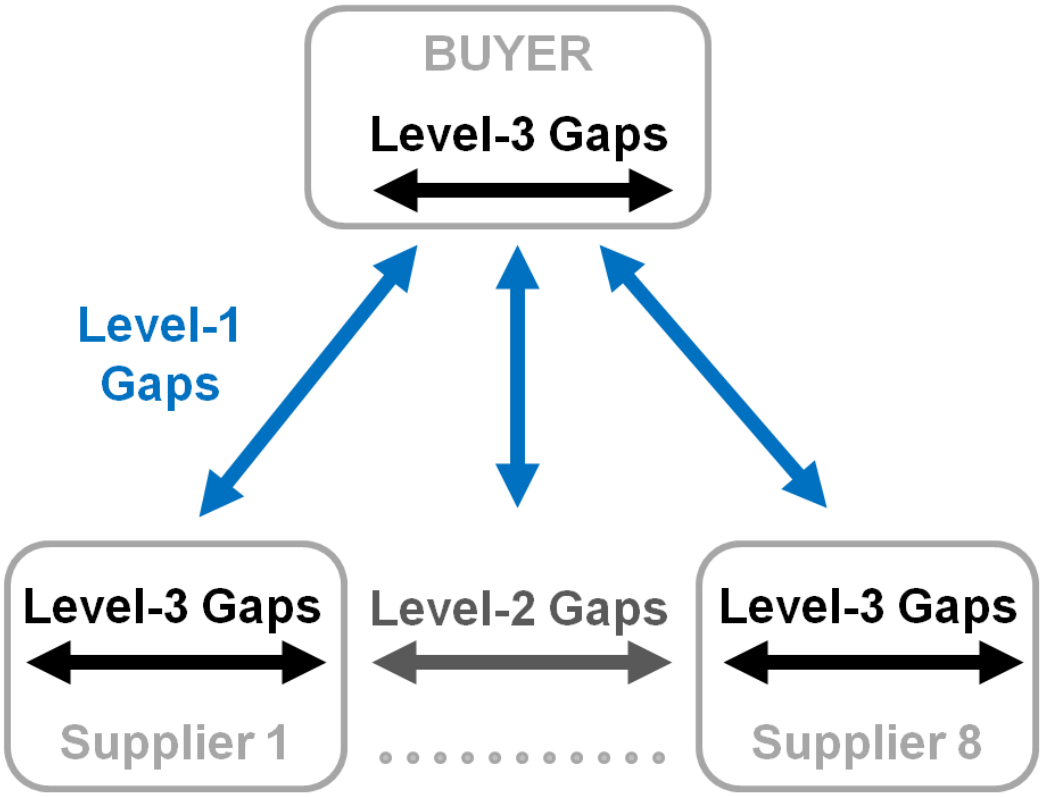

Fig. 2 Perception gaps between stages (Level-1), within a single stage (Level-2), and within each of the entities in a stage (Level-3).

Logically and structurally there are three levels in the supply chain, where the perceptions can be compared: between two companies of the two adjacent tiers; between companies within the same (supplier or buyer) tier; between individual people within any firm of the supply chain.

The Level-1 gaps are the perception differences between the two adjacent tiers of a supply chain, and reflect the gaps between the suppliers and buyer's perceptions as a collective view of the organisation on the performance criteria (or fulfilment standards). Level-1 gaps therefore represent the major impediment to SCI, which is the original motivation for Slack's

model [9]. Level-1 perception gaps often imply the need for organizational level communication, openness in sharing information across supply chain (between organisations) [53], closer alliances in setting strategic goals [54], supplier development [55], and defining market positioning. Furthermore, Level-1 gaps may also suggest the need for coordination mechanisms, such as the appropriate design of the contracts between the buyer and supplier [56,57] or coordinated inventory planning [58], which can significantly increase supply chain performance.

Hypothesis 1: *Level-1 perception gaps exist at a significant level between the buyer and its suppliers; and the contents and significance of the perception gaps varies with different suppliers.*

The Level-2 gaps are the perception variations, also with a collective view of organisation, but between the different suppliers (or buyers) *within* the same tier. These variations reflect the unique business nature of specific suppliers and how they might factor-in to the understanding of the performance objectives for the buyer. Level-2 gaps analysis often implies that there is a need to manage and coordinate with different types of suppliers in a customized way in order to achieve consistent performance across the supply base. "One-size fit all" approach to different suppliers could be the cause of the Level-2 perception gaps.

Hypothesis 2: *Level-2 perception gaps do exist at a significant level between the suppliers in the same tier. For each supplier-supplier pair the gaps may differ for each performance criteria for which the perceptions are measured.*

The Level-3 gaps are the perception gaps between the individual people or functions within one supplier or buyer, which is mainly due to the different views between the individual respondents. If a high degree of variance is in presence, it could be the result of a lack internal communication or the lack of the processes of doing it. The lack of internal coherence of views within an organization is surely a critical but negative measure of capability. The cause could be down to the ways the employees are trained. It may also relate to the organizational culture. The Level-3 gaps could be a source of motivation or lack of it for improving the company's personnel management and employee training. Our analysis in Section 5.4 provides specific guidance on how internal communication might be improved.

Hypothesis 3: *Level-3 perception gaps (within a supplier or a buyer) do exist at a significant level between the individuals, who may have different views in connection with their roles or positions in the company. The significance of this gap may vary for each supplier or buyer.*

Table 1 The *3-Level Gaps Model* and its implications

Levels	**Where**	**Descriptions**	**Implications**	**Remedies**
Level-1	Between buyer and suppliers	SC Requirement and fulfilment gaps	Impediments to supplier development and SC integration	Long term, close partnership; information sharing; joint planning
Level-2	Between different suppliers in the same tier	Suppliers differentiation gaps	Hinders the optimisation of consistent quality and cost	Tailored relationship and bespoke processes and KPI to each type of supplier
Level-3	Between people who may or may not have different roles.	Role based perspective gaps	Barriers to internal operational coordination	Internal communication; adequate employee training; empowerment.

The above model has hopefully advanced our understanding of the perception gaps beyond the scope covered by the current literatures. The quantitative measures of those gaps can be observed through proper data collection and data analysis. The result can be used separately to guide the specific management effort in different levels, which hopefully may harmonize the understanding of performance objectives and consequently help managing the resources to tackle the areas that are most in need. Looking across the three different levels together, the comparison of the measures can reveal a pattern of "gaps profile". This profile offers a brief overview and can be used to guide the managers to tackle the most *needed levels* in terms of "action economy". In conjunction with the diagramming model shown in Figure 2 above, a summary of the 3-Level Gaps Model can also be given in Table 1 with more emphasis on their managerial implications and remedies.

In order to argue the validity of the above model, one must first verify the significance of the existence of the three gaps, not just their existence, which may be taken as obvious. Secondly, it must also show that the model is theoretically acceptable in terms of the

independence between the gaps at the three levels, and consequently each of them may impact upon entirely different aspects of the supply chain measures.

In answering the RQ2, it becomes evident that the above model described in Table 1 is theoretically helpful in identifying the three independent perception gaps embedded in a supply chain, because it helps to map out each perception gap with the problems often encountered in SCM. This model, thus, can serve as look-up table for managers to identify the possible root causes of the problem. Knowing full well that the problems listed in the model may have more-than-one causes, but it is arguable that the model does give managers a clear guidance for streamlining the problems to their different categories of perception gaps as an additional theoretical dimension to already existed ones. It can also be argued that each of the causal linkages mapped out in the model between the perception gap and the possible problems it caused is not necessarily counterintuitive as such, but putting them together symmetrically as a framework does elevate our understanding at a higher theoretical level.

Table 2 The suppliers and the services they provide

Supplier	Service
1	Motor Dealer
2	Motor Dealer
3	Body shop
4	Body shop
5	Body shop
6	Accident repairer
7	Accident repairer
8	Electrical testing

4. Verifying the model

4.1. Survey and data collection

Working with the senior management team of the Motor-Insurer, we identified a group of eight key *suppliers* plus the *buyer* (the Motor-Insurer itself) as the respondent-base. The suppliers are coded as Supplier 1,…,8 to mask their real identity. The services and products provided by the suppliers are listed in Table 2. These suppliers were selected based on the highest relevance and appropriateness for the research questions: following a Pareto pattern [59], their size and relationship to the buyer made them the crucial first tier suppliers.

Our key contacts at the eight suppliers and the buyer were asked to instruct their staff at all levels of the organisation to complete a simple on-line questionnaire. Altogether 120

participants from the eight suppliers and 87 respondents from the buyer were identified and they all dutifully responded to the questionnaire. The respondents are coded as illustrated in Figure 3. All the participants were asked to identify their role in the company being one of the front line staff, team leaders, managers, senior managers or others. The purpose for this stratification was to allow for in-depth investigation into the connections between the roles they play internally and the views they behold.

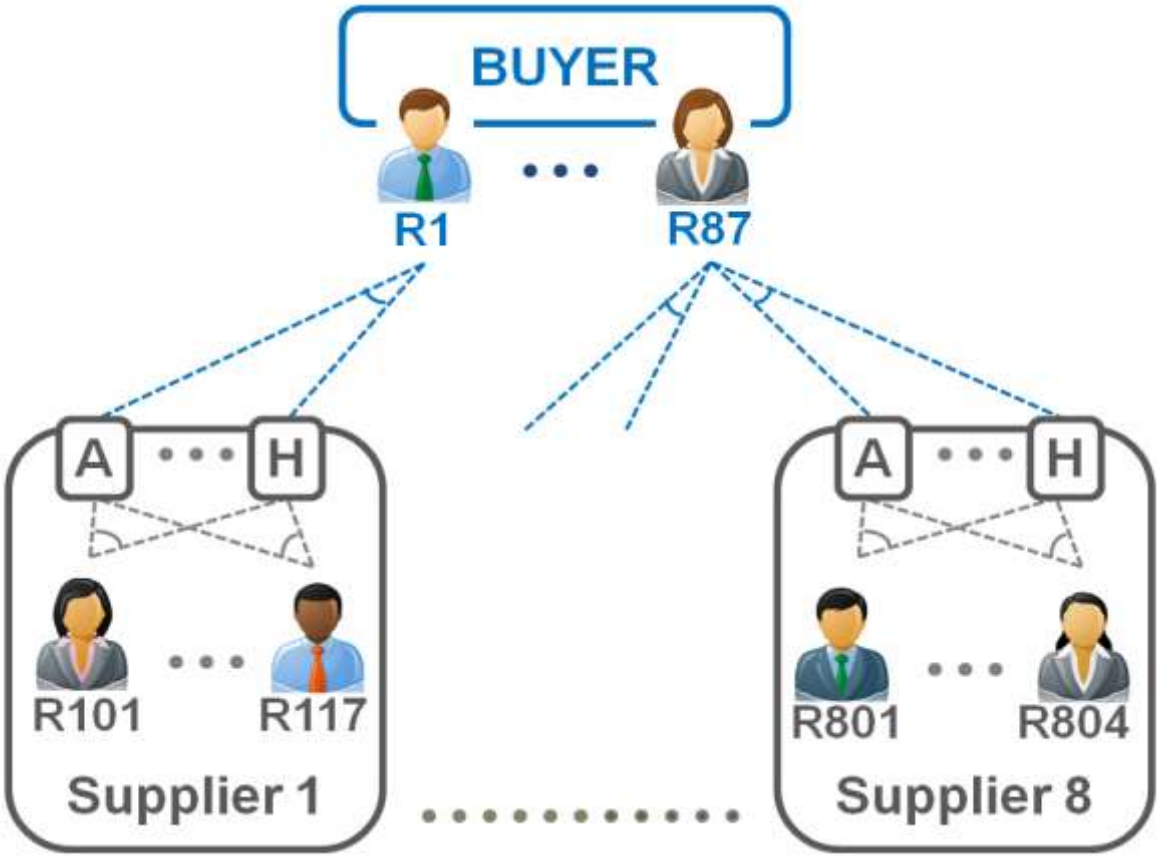

Fig. 3 Perception of the respondents at the suppliers and the buyer regarding the performance measures

The first question in the survey is the key question analysed in this paper (other survey questions are used in separate researches). It asked the respondents to allocate 100 points between the eight performance criteria (coded from ‘A’ to ‘H’) below in terms of the importance to Motor-Insurer’s business:

A. Service with a real "wow" factor being prepared to go the extra mile
B. Innovative products or services
C. Low price/charges
D. Fast response to your requests

E. Being on time

F. Not making mistakes

G. Personal touch

H. Dealing well with problems and queries

This question represents the suppliers' and buyer's perceived *weight* or priorities of the importance on those eight criteria of the supplier's performance measures. These criteria were developed through the synthesis of the five performance objectives (quality, speed, dependability, flexibility and cost) identified by Slack *et al.* [9] and the model of Service Excellence by Johnston & Clark [60], which identified four factors of service (deliver the promise, deal with problems and queries, provide a personal touch and go the extra mile). Since it is not the main interest of this paper to determine how appropriate this set of supplier performance criteria is, we will not extend the discussion of the criteria in this paper. Understandably, the content coverage of these performance criteria may have the effect on the performance management, but will not affect the methodological validity for testing the hypotheses.

The correctness of the data has been systematically achieved based on the taxonomy of dirty data by [61]. The supplier names, the buyer name, and the names of the respondents in each company have been masked with unique identifying codes. When needed, the codes can be tracked back to their originals through lookup tables.

Table 3 The vectors/matrices and the mathematical expressions

Vector/Matrix Title	Value in Vector/Matrix	Vector/Matrix Title	Value in Vector/Matrix
Average1 (Matrix)	$\mu_r(u_{rsm})$	Average11 (Matrix)	$\mu_r(w_{rsm})$
Average2 (Vector)	$\mu_m(\mu_r(u_{rsm}))$	Average12 (Vector)	$\mu_m(\mu_r(w_{rsm}))$
Average3 (Vector)	$\mu_s(\mu_r(u_{rsm}))$	Average13 (Vector)	$\mu_s(\mu_r(w_{rsm}))$
Average4 (Matrix)	$\sigma_r(u_{rsm})$	Average14 (Matrix)	$\sigma_r(w_{rsm})$
Average5 (Vector)	$\mu_m(\sigma_r(u_{rsm}))$	Average15 (Vector)	$\mu_m(\sigma_r(w_{rsm}))$
Average6 (Vector)	$\mu_s(\sigma_r(u_{rsm}))$	Average16 (Vector)	$\mu_s(\sigma_r(w_{rsm}))$
Average7 (Matrix)	$\varphi_r(u_{rsm})$	Average17 (Matrix)	$\varphi_r(w_{rsm})$
Average8 (Vector)	$\mu_m(\varphi_r(u_{rsm}))$	Average18 (Vector)	$\mu_m(\varphi_r(w_{rsm}))$
Average9 (Vector)	$\mu_s(\varphi_r(u_{rsm}))$	Average19 (Vector)	$\mu_s(\varphi_r(w_{rsm}))$

4.2. Mathematical formalism

In this section, we introduce a mathematical notation to represent the collected data and analysed results. This notation is essential for the succinct calculations used in the summary tables, and for easy communication of the statistical analysis. The notation consists of the sets, parameters, and functions. The vectors and matrices in the summary tables are then expressed in terms of this notation. Table 3 presents the titles for the vectors/matrices presented throughout the paper and in the supplement [62].

We also define the following:

Sets

S: set of suppliers

R: set of respondents; $R = R' \cup (\cup_{s \in S} R_s)$

R': set of respondents at the buyer (who can weigh the performance measures for more than one supplier)

R_s: set of respondents at supplier s (who can weigh the performance measures only for their company)

M: set of performance measures/criteria (same for all suppliers)

Parameters

w_{rsm}: weight given by respondent r at the buyer for performance measure m of supplier s

u_{rsm}: weight given by respondent r at supplier s for performance measure m of supplier s

Functions

$\mu_{i_n}(x_{i_1,\cdots,i_n,\cdots,i_N})$: average of x values over the values of index i_n, where x is matrix

$\sigma_{i_n}(x_{i_1,\cdots,i_n,\cdots,i_N})$: standard deviation of x values over the values of index i_n, where x is matrix

$\varphi_{i_n}(x_{i_1,\cdots,i_n,\cdots,i_N})$: coefficient of variation (CV) of x values over the values of index i_n, where x is matrix; $\sigma_{i_n}(x_{i_1,\cdots,i_n,\cdots,i_N}) = \sigma_{i_n}(x_{i_1,\cdots,i_n,\cdots,i_N})/\mu_{i_n}(x_{i_1,\cdots,i_n,\cdots,i_N})$

4.3. Statistical analysis

Summary statistics computed for the data include the average, standard deviation (stdev) and coefficient of variation (stdev/mean) for the subsamples. Sample average is an estimate of the population mean, which is a measure of central tendency in data. While standard deviation and *coefficient of variation* (*CV*) are both the measures of variability (spread) in data, the

latter is a more reliable measure, since it scales the variability with respect the magnitude of the central value (average).

Throughout the study, perception gaps have been identified and tested through repeated application of formal statistical tests, whose references are given in Appendix H of the supplement [62]. A fundamental issue is the selection of the appropriate statistical tests for measuring the statistical significance of the hypothesized differences in the *weight* values [63]. The most basic decision to be made is whether parametric (*t*-test, ANOVA) or nonparametric tests (Mann-Whitney, Kruskal-Wallis) should be applied. When applicable, parametric tests are preferred due to their power, that is, their requirement for smaller sample sizes to draw conclusions with the same degree of confidence. However, parametric tests are applicable only when the data follows parameterized distributions, such as the requirement of normal distribution for the *t*-test. Nonparametric test such as Mann-Whitney and Kruskal-Wallis, on the other hand, use the rank data to compute the test statistics, and do not require the data to come from a particular distribution [63].

For deciding on the selection of the test type (parametric vs. nonparametric) Shapiro-Wilk test has been applied to test normality of data subsamples. The parametric *t*-test has been applied for comparing differences among two random samples that both follow normal distribution. When any of the distributions were not following normal distribution, the nonparametric Mann-Whitney test has been applied instead of the *t*-test to test differences between two samples. The nonparametric Kruskal-Wallis test has been applied for comparing differences among three or more samples. The parametric ANOVA test would have been applied for comparing differences among three or more samples if all followed normal distribution [63]; however, the conditions for the application of this test were not satisfied in the study.

5. Results and implications

5.1. Survey and data collection

One of the goals of this paper is to identify whether perception gap exists with respect to the importance of SC performance criteria. Table 4 presents the *averages* of the *weights* for each performance criterion (‘A’ through ‘H’) for each supplier, as perceived the *supplier*s. Table 5 presents the same *averages* as perceived by the *buyer*. The differences in value suggest the existence of perception gaps, and that will have to be investigated and tested through appropriate statistical tools.

Table 4 Matrix Average1 of *averages* of the *weights* for each performance criterion (A through H) for each supplier, as perceived from the *supplier*'s side

	Average1									
Supplier	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Average2**	**Count**
1	13.41	7.59	28.29	9.24	12.24	7.12	6.65	15.47	**12.50**	17
2	10.39	9.61	14.50	9.67	14.28	12.56	11.11	17.89	**12.50**	18
3	9.39	9.89	22.61	10.00	7.83	10.61	6.22	23.44	**12.50**	18
4	27.86	10.05	8.77	13.55	8.55	7.86	13.09	10.27	**12.50**	22
5	28.26	8.54	11.49	11.17	10.66	9.20	8.94	11.74	**12.50**	35
6	11.67	8.33	18.00	12.00	2.00	20.00	9.00	19.00	**12.50**	3
7	24.00	13.00	13.00	10.67	9.67	9.67	9.67	10.33	**12.50**	3
8	34.25	5.25	17.00	10.00	14.00	8.00	4.00	7.50	**12.50**	4
Average3	**20.25**	**9.04**	**15.88**	**10.90**	**10.48**	**9.62**	**9.15**	**14.68**		**Total: 120**

Table 5 Matrix Average11 of *averages* of the weights for each performance criterion (A through H) for each supplier, as perceived by the *buyer*

	Average11									
Supplier	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Average12**	**Count**
1	16.46	4.63	15.04	15.21	11.00	10.71	6.33	20.63	**12.50**	24
2	13.57	3.00	5.71	12.57	12.71	14.00	7.14	31.29	**12.50**	7
3	20.38	1.88	6.25	18.00	13.25	10.13	7.38	22.75	**12.50**	8
4	11.69	3.88	12.19	12.75	11.38	14.81	7.06	26.25	**12.50**	16
5	17.88	1.76	9.20	13.20	8.72	15.76	7.56	25.92	**12.50**	25
6	18.63	3.37	8.00	12.96	13.04	12.30	9.41	22.30	**12.50**	27
7	8.00	4.00	6.00	10.00	10.00	5.00	3.00	54.00	**12.50**	5
8	16.52	4.29	8.38	13.29	10.29	12.62	10.38	24.24	**12.50**	21
Average13	**16.37**	**3.41**	**9.76**	**13.61**	**11.11**	**12.70**	**7.89**	**25.15**		**Total: 133**

Table 6 *p*-values for the Level-1 gaps for each (supplier, criterion) pair for each of the performance criterion

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
1	0.8526	**0.0225**	0.1101	0.1815	0.9041	0.2740	0.7573	0.8944
2	0.5153	**0.0043**	**0.0125**	0.2359	0.7010	0.3442	0.2303	0.5051
3	1.0000	**0.0319**	**0.0825**	0.3375	0.2275	0.9555	0.7764	0.5955
4	**0.0353**	**0.0562**	1.0000	0.4110	0.2808	**0.0824**	**0.0357**	**0.0025**
5	**0.0232**	**0.0000**	0.1234	0.3514	0.1520	**0.0575**	0.1749	**0.0023**
6	1.0000	0.1502	0.1152	0.9720	**0.0373**	0.2366	0.7801	1.0000
7	**0.0148**	**0.0101**	**0.0734**	1.0000	0.9480	0.1685	**0.0314**	**0.0336**
8	0.8526	0.6142	0.1313	0.4994	0.5550	0.2636	**0.0800**	**0.0343**

Table 7 *p*-values for the Level-1 gaps for each criterion, over all suppliers

First Vector	Second Vector	Test Employed	*p*-value	Test Result
Average1.A	Average11.A	Wilcoxon	0.3828	
Average1.B	Average11.B	Wilcoxon	0.0078	*
Average1.C	Average11.C	Wilcoxon	0.9453	
Average1.D	Average11.D	Wilcoxon	0.0391	*
Average1.E	Average11.E	Wilcoxon	0.7422	
Average1.F	Average11.F	Sign test	0.7266	
Average1.G	Average11.G	Wilcoxon	0.4609	
Average1.H	Average11.H	Sign test	0.0703	*

5.2. Level-1 gaps

The first sets of statistical tests are aimed at revealing the Level-1 gaps *between* two neighbouring supply chain *tiers*. These gaps are revealed through the identification of statistically significant differences in the means of the weight values. To this end, the parametric *t*-test and the nonparametric Mann-Whitney test have been applied for measuring the significance of the differences between the means of two random samples: The weight values of the supplier and the buyer, regarding each (supplier, buyer) pair. The selection of the appropriate test on each mean of the weight value depends on the normality of the samples' distribution, and the process of the selection is documented in Appendix B of the supplement (Supplement). Table 6 presents the p-values (whose lower values denote higher statistical significance) for the Level-1 gaps for each (supplier, criterion) pair. The statistically significant differences for p_0=0.10 are shown in bold.

Having observed the existence of the Level-1 gaps for "supplier- criterion" pairs, the next question is whether the gaps for at least some of the criteria are statistically significant enough. To this end, Wilcoxon test and sign test were applied to compare the means of two paired samples: the average weight values of the supplier (Average1) against that of the buyer (Average11) for each criterion. The selection of the appropriate test methods again depends on the normality of the samples, and this information is given in Appendix B of the supplement [62].

Table 7 presents the p-values, whose smaller values denote higher statistical significance) for the Level-1 gaps for each criterion between two neighbouring supply chain tiers. The results in Table 6 and 7 support Hypothesis 1, showing that perception gaps exist for criteria B, D, and H with credible significance.

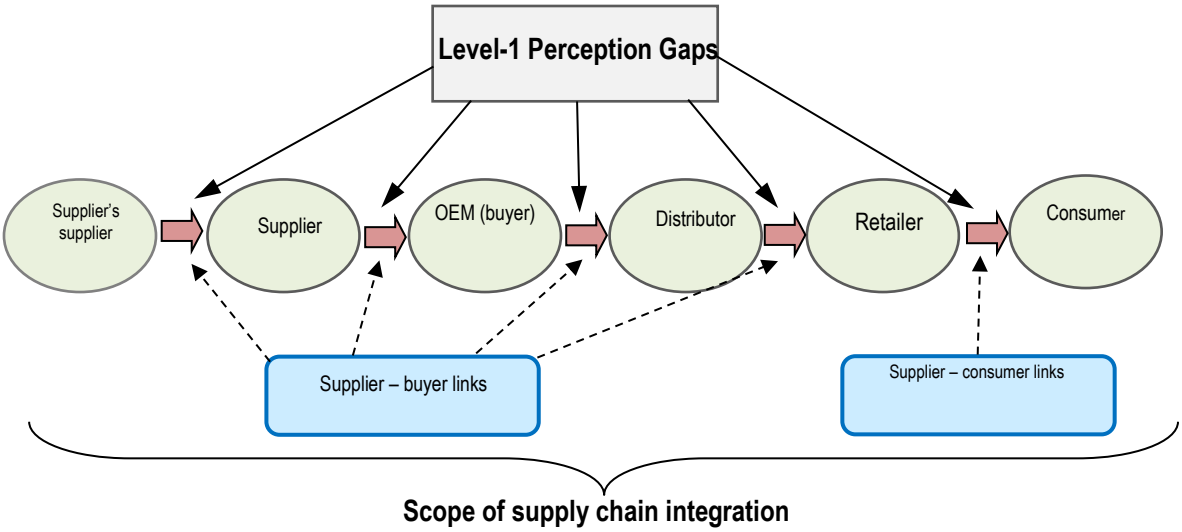

Fig. 4 Implication of Level-1 perception gaps

The implication of the Level-1 gaps can be profound to SCI. To begin with, the literature on the key success factors fall short of addressing the existence and critical role the perceptions gaps play in achieving seamlessly integrated supply chain in terms of information flow and material value-adding flow. The model has been verified from a supplier to buyer link, but it could also be extrapolated to the supply chain to consumer link (or supplier to consumer link). Notwithstanding that it has not been explicitly tested as such in this research, empirical experiences and many studies have already alluded that the perceptions gaps or expectation discrepancies also exist in the supplier-consumer link. Theoretically the authors do admit that the measures of the Level-1 perception gaps in the supplier-buyer link are different to those in the supplier-consumer links. In fact every link is different in their measures for perception gaps. However, it remains the authors' proposition that the model of Level-1 gaps do cover the entire supply chain theoretically as shown in Figure 4.

The Level-1 perception gaps are thus a generalised theoretical concept that covers all the supply-buyer It can be observed that:

- Both gaps are in the same flow direction as shown in the Figure 4
- Both gaps are at the highest supply chain level, not within a specific tier or within an organisation
- Both gaps address the discrepancies on the measures of supply and demand.

Although this research is based on the case of supplier-buyer perception gaps, studies show strong evidence of similar cases between suppliers and consumers [16,64]. Hence, a conjectural implication would be that the Level-1 perception gap not only models the

supplier-buyer integration but also the supply chain–consumer integration. In other words, understanding the perceptions gaps throughout the supply chain not only helps the better integration of within the supply chain but also beyond the supply chain to consumer-integration; the impact of the perception gaps is as critical to the buyer-supplier as to the supply chain–consumer. Nevertheless, the actions to narrow down the perception gaps may have to be very different due to the difference of purchasing behaviour differences.

5.3. Level-2 gaps

This type of gap is *within* a supply chain *tier*. As in the Level-1 gaps, the parametric *t*-test and the nonparametric Mann-Whitney test have been applied for measuring the significance of the differences between the means of two random samples. This time, however, the samples were the *weight* values of two suppliers, which (without loss of generality) we will refer to as First-Supplier and Second-Supplier for each criterion.

Table 8 Statistically significant Level-2 gaps (marked with T)

Supplier Pair	A	B	C	D	E	F	G	H	Count of T
1-2	T	T	T	F	T	T	T	T	**7**
1-3	T	T	T	F	T	T	F	T	**6**
…	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**	**…**
7-8	F	F	F	F	F	F	T	F	**1**
Count of T	**17**	**14**	**15**	**7**	**20**	**17**	**19**	**19**	**Total: 128**

Table 8 presents a summary of the statistical significance of the Level-2 gaps, and the full Table is given in Appendix C of the supplement (Supplement). In Table 8, T (True) denotes that the difference is statistically significant at p=0.10 (one-sided), whereas F (False) denotes that the difference is not significant. A considerable percentage (57%) of the table cells contains the value T, thus proving the Hypothesis 2.

When the number of gaps are observed for each criterion (the bottom row in Table 8), criteria E, G, and H have the highest values, suggesting that significant gaps exist among an overwhelming percentage of the supplier pairs for these criteria. The selection of the appropriate test depends on the normality of the samples, and the process is documented in Table 5 of the supplement (Supplement). The results for Level-2 gaps also suggest that the gaps *within* the supplier *tier* is largely independent to that of the Level-1 as shown in criteria E and G, as opposed to B and D for Level-1.

5.4. Level-3 gaps

The Level-3 gaps are *within* a supplier or buyer. Tables 9 displays the *coefficient of variations (CV)* of the *weights* for each (supplier, performance criterion) pair, as perceived by the *supplier*. Table 10 presents the same statistics for the weights perceived by the *buyer*. The values in these tables are obtained through the division of the standard deviation values (in Appendix A of the supplement) by the average values in Tables 4 and 5.

Table 9 Matrix (Average7) of *coefficient of variations (CV)* of the *weights* for each performance criterion (A through H) for each supplier, as perceived at the *supplier* tier (the highest three and lowest two values in the matrix are shown in bold)

	Average7									
Supplier	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Average8**	**Count**
1	0.76	0.75	1.23	0.71	0.72	0.63	0.67	0.73	**0.78**	17
2	0.49	0.47	0.83	0.66	**0.33**	**0.46**	0.40	0.45	**0.51**	18
3	0.82	1.04	1.16	0.86	0.74	0.97	0.84	1.21	**0.95**	18
4	0.86	**1.45**	**1.41**	**1.53**	0.80	0.94	0.77	0.98	**1.09**	22
5	0.95	0.74	0.86	0.81	0.56	0.62	0.71	0.60	**0.73**	35
6	0.78	0.80	0.59	0.52	0.87	0.50	0.87	0.61	**0.69**	3
7	0.08	0.20	0.08	0.11	0.16	0.16	0.16	0.06	**0.13**	3
8	1.29	1.18	0.70	0.82	0.78	0.78	0.74	0.77	**0.88**	4
Average9	**0.75**	**0.83**	**0.86**	**0.75**	**0.62**	**0.63**	**0.64**	**0.68**	**0.72**	**Total: 120**

These matrices Average 7 and Average 17 in Tables 9 and 10 suggest that coefficient of variability are not uniform. The *highest* CV on the supplier side (Table 8) is observed within Supplier 4, especially regarding criteria D (CV=1.53), B (CV=1.45), and C (CV=1.41), indicating a large Level-3 perception gap. This means that the weights given by the 22 respondents within Supplier 4 for D, B, and C have the highest variability when compared with other (supplier, criterion) pairs. The *lowest* CV values on the supplier side are observed for Supplier 7. Since the number of respondents for Suppliers 6, 7, and 8 are very few, we focus on the other suppliers, and observe that Supplier 2 has the least CV values overall, especially regarding E (CV=0.33) and G (CV=0.40). This means that the weights given by the 18 respondents within Supplier 2 are very consistent, indicating low levels of the Level-3 perception gaps.

On the buyer side, highest CV values is for (Supplier 5, B) with CV=2.47, which is much higher than the next highest CV value (CV=1.91). Thus, the 25 respondents at the buyer

(Motor-Insurer) have great variability with respect to how much *weight* they give to criterion B for Supplier 5. The smallest CV value on the buyer side is with regards to the importance of D for Supplier 8 (CV=0.58).

A formal statistical test has been carried out (Appendix D of the supplement), yielding statistically significant Level-3 gaps within all the suppliers. Hence Hypothesis 3 has been tested positive.

Table 10 Matrix (Average17) of *coefficient of variations (CV)* of the weights for each performance criterion (A through H) for each supplier, as perceived at the *buyer* (the highest and lowest values in the matrix are shown in bold)

	Average17									
Supplier	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Average18**	**Count**
1	0.94	1.91	1.44	0.94	0.85	0.99	0.96	1.31	**1.17**	24
2	0.87	1.22	1.90	0.75	0.78	1.36	1.06	1.01	**1.12**	7
3	1.44	1.79	0.88	0.95	0.86	0.69	1.00	1.43	**1.13**	8
4	0.71	1.52	1.69	0.67	0.74	0.90	0.89	0.87	**1.00**	16
5	1.27	**2.47**	1.36	0.74	1.13	0.87	1.23	1.00	**1.26**	25
6	1.42	1.29	1.06	0.91	0.69	0.84	0.75	0.81	**0.97**	27
7	1.14	1.05	1.09	1.06	1.06	1.22	0.91	0.78	**1.04**	5
8	0.67	1.60	0.98	**0.58**	0.67	0.74	0.79	0.92	**0.87**	21
Average19	**1.06**	**1.60**	**1.30**	**0.83**	**0.85**	**0.95**	**0.95**	**1.02**	**1.07**	**Total: 133**

The next analysis is to establish the positioning of the individual respondents with respect to each other, and to identify the subgroups of consistent respondents. For this purpose, hierarchical clustering and multi-dimensional scaling methods from the machine learning discipline [65] have been employed. The resulting analysis gives us the clue to what can be done to close the Level-3 perception gap, and to achieve consistency throughout the company. These results are provided in the Appendices E, F, and G of the Supplement [62].

5.5. Findings and discussion

As has started above, close range research of the perception gaps and their impact on SCI is a rich, sophisticated and penetrating exploration of epistemological issues concerning the deep rooted causes of many management shortfalls. Thus, it pushes one step further towards making some fundamental claims regarding to academic understanding of roles of perception gaps in SCM and empirical guidance to deliver some tangible benefits.

Academic implications

Learned from the above analysis and results, we are now in a lot more confident position to address the research questions set forth in Section 1.

For the RQ1, statistical analysis of the survey data reveals the statistical significance of perception gaps between the collective views of supplier-buyer pairs and supplier-supplier pairs, as well as within groups of individual respondents. Thus the answer becomes clearly straightforward that the perceptions gaps do exist at all three levels at a significant level in a supply chain. The consequence of dissatisfaction from both buyers and customers, or even the complete broken down supply chain intermediation function can now be approached from a perception gaps' perspective.

For the RQ2, as a conceptual framework discussed in Table 1, the 3-Level Gaps Model can be helpful in identifying not only the sources but also the locations of the perception gaps. The statistical data analysis and hypotheses testing have demonstrated the independence of the three types of perception gaps, thus verified the category validity of the model. This shows that the gap profile against defined measures can vary from one level to another. Theoretically, each perception gap at a specific level has now been related to a corresponding supply chain problem. The model basically defined the three categorised sources of perception gaps and mapped them to their corresponding SCM problems, namely: Level-1 gaps are linked to buyer supplier coordination; Level-2 gaps are linked to the rationalisation within a single supply base – achieving consistency and harmony in between suppliers horizontally; Level-3 gaps links to the participating organisation's internal congruence and communication effectiveness. In a reverse direction, the model provided guidance from problems to the possible root causes arising from perception gaps. In short, the answer to RQ2 is that the model developed in this research is helpful to identify the types of perception gaps in order to track down the root causes of SCM problems, albeit they may not be the only root causes.

For RQ3, as discussed in Section 1, part of RQ3 is meant to be provocative and may not be fully answered. Surely a better understanding of the perception gaps will aid the supply chain strategic decision making in the context of improving SCM to achieve better performances. In fact the hidden question could be that "has the developed model provided any such better understanding?". To answer this, there are three positive arguments we can draw.

First, the data analysis shows a significant level of the perception gaps in existence, providing a new quantitative understanding on the severity of the perception gaps. Second, moving from a terminology to a defined framework revealing all the relevant perception gaps and their locations of existence in a supply chain structure; this development provides a new

understanding in terms of their portfolio and embedding structure in a supply chain. Third, the model enables a possible causal relation from the perception gaps to some of the SCM problems, adding a new understanding of its managerial relevance and implication of the issue. Hence, the answer is that the model will help supply chain performance improvement. In another words, the model is theoretically helpful in categorising and streamlining the performance delivery "mechanisms".

Supply chain performances can only be delivered, measured and improved through a specific "mechanism". The Level-1 pair of supplier-buyer is one of the mechanisms that deliver the "supplier performance" in the eyes of the buyer. The Level-2 is the mechanism that delivers the supplier base capabilities, including reliable standard and potential synergy of the supply network. Toyota's Keiretsu system is precisely the mechanism that delivers such performance. Level-3 is the mechanism that embodies the performance capability at the individual "cells" level. The participating organisation's internal performances such as capacity, flexibility, knowledge management, skill training are examples. Now that, with the 3-Level Gaps model, the performances are now dovetailed to their delivery mechanism, and consequently the perception gaps become the ratchet within, that help or hamper the function of the mechanism.

Managerial implications

Not to overstate any promising practical benefits, we believe a further research may be required to investigate explicitly the impact of perception gaps on the supply chain performances. But for now, some practical implications may still be plausible.

- First practical implication is that it puts new measures into the supply chain's health-check. Measures of perception gaps do not always appear on the measurement list, nor do they replace any existing ones, but only to add-on and to complement them. The measures can be coded as: PG-1, PG-2 and PG-3, corresponding to the perception gaps at each of the 3 levels.
- Secondly, when the supply chain performance falls short of what is expected, with the 3-Level Gaps Model, managers can map-out from the performance measures to the delivery mechanisms and finally to the specific perception gaps.

To summarise, there are three key practical implications of the perception gaps to the SCM. First, understanding and measuring the Level-1 gaps facilitates the SCI by making sure what suppliers deliver is what buyers really want; closing the Level-2 gaps will help to harmonise the consistency in quality and cost across the supplier base; managing the Level-3 gaps will help the supplier internal communication and congruence.

6. Conclusions

Overall, the research reviewed the literature on the perception gaps in the context of SCM. Our first hand data collection and subsequent thorough statistical analysis on the perception gaps revealed a significant level of existence in the chosen supply chain case. The research finds that the *perception gaps* do exist at the three defined levels of a supply chain, instead of the one level (Level-1) as suggested in Slack's model. The perception gaps at the Level-2 and Level-3 as defined in the 3-Level Gaps Model have also shown some distinct implications to the supply chain performance management over and above what has been discovered at the Level-1. The *3-Level Gaps Model* has been created to represent and map out the co-existence of the three types of perception differences. It could be suggested to the future researchers that despite the abundance of literature, supply chain integration (SCI) could have taken a completely different but perhaps more effective approach, starting from discovering the perception gaps as one of the underlying causes to many performance shortfalls.

Further research could involve the mapping of inter-connections of the perception gaps with many operational factors in order to understand their influence on the supply chain relationship and supply chain performances. It is the authors' planned next research to look into the perception gaps and their direct impact on supply chain performances by using statistical techniques on the text data gathered in the survey.

Appendix A. Standard deviations of the weight values

Table 1 Matrix Average4 of *standard deviations* of the weights for each of the performance criterion (A through H) for each supplier, as perceived at the *supplier* stage.

	Average4									
Supplier	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Average5**	**Count**
1	10.25	5.68	34.90	6.57	8.76	4.50	4.49	11.29	**15.48**	17
2	5.10	4.51	11.99	6.34	4.76	5.80	4.48	8.02	**7.18**	18
3	7.74	10.28	26.14	8.56	5.78	10.30	5.20	28.48	**16.27**	18
4	23.91	14.56	12.39	20.66	6.86	7.38	10.04	10.09	**15.42**	22
5	26.77	6.32	9.83	9.09	5.92	5.73	6.34	7.02	**13.04**	35
6	9.07	6.66	10.58	6.24	1.73	10.00	7.81	11.53	**9.23**	3
7	2.00	2.65	1.00	1.15	1.53	1.53	1.53	0.58	**4.83**	3
8	44.18	6.18	11.94	8.21	10.98	6.27	2.94	5.74	**17.87**	4
Average6	**21.45**	**8.64**	**19.66**	**11.20**	**6.81**	**7.08**	**6.82**	**14.12**		**Total: 120**

Table 2 Matrix Average14 of *standard deviations* of the weights for each of the performance criterion (A through H) for each supplier, as perceived at the *buyer* stage.

	Average14

Supplier	A	B	C	D	E	F	G	H	Average15	Count
1	15.55	8.85	21.65	14.24	9.30	10.57	6.06	26.93	**16.13**	24
2	11.86	3.65	10.87	9.47	9.91	19.10	7.56	31.57	**16.47**	7
3	29.39	3.36	5.52	17.09	11.37	6.96	7.41	32.54	**18.03**	8
4	8.36	5.89	20.54	8.59	8.47	13.28	6.30	22.93	**14.31**	16
5	22.75	4.34	12.49	9.81	9.82	13.65	9.30	25.86	**16.39**	25
6	26.36	4.33	8.45	11.83	8.95	10.36	7.05	18.14	**14.54**	27
7	9.08	4.18	6.52	10.61	10.61	6.12	2.74	42.04	**21.96**	5
8	11.03	6.86	8.19	7.77	6.92	9.34	8.22	22.26	**12.26**	21
Average16	**19.04**	**5.89**	**14.12**	**11.10**	**9.00**	**11.57**	**7.44**	**25.34**	**15.46**	**Total: 133**

Appendix B. Selecting the statistical test for Level-1 Gaps

Table 3 p-values obtained in the Shapiro-Wilk normality tests at the *Supplier stage*. The tests analyze whether the weights given *by each supplier for each criterion* show normal distribution or not. p-values *less than 0.10* (shown in bold) suggest statistical evidence that the underlying distribution is *not* normal.

	A	B	C	D	E	F	G	H
1	**0.0989**	0.4565	**0.0000**	0.1242	0.2169	0.2800	0.3138	0.4685
2	0.1578	0.8146	**0.0000**	**0.0001**	0.9431	0.8310	0.8051	0.9020
3	**0.0914**	**0.0197**	**0.0008**	**0.0998**	0.2217	**0.0361**	**0.0020**	**0.0000**
4	**0.0046**	**0.0000**	**0.0000**	**0.0000**	0.1027	**0.0320**	**0.0684**	**0.0039**
5	**0.0000**	**0.0271**	**0.0005**	**0.0000**	0.1423	**0.0129**	0.2451	0.1677
6	0.3172	0.1436	0.3631	0.4633	**0.0000**	1.0000	0.1224	0.8564
7	1.0000	0.3631	1.0000	**0.0000**	0.6369	0.6369	0.6369	**0.0000**
8	**0.0272**	0.3954	0.2793	0.9086	0.8027	0.9571	0.7335	0.2725

Table 4 p-values obtained in the Shapiro-Wilk normality tests at the *Buyer stage*. The tests analyze whether the weights given *by the buyer for each supplier-criterion combination* show normal distribution or not. p-values *less than 0.10* (shown in bold) suggest statistical evidence that the underlying distribution is *not* normal.

	A	B	C	D	E	F	G	H
1	**0.0115**	**0.0000**	**0.0000**	**0.0043**	**0.0116**	**0.0005**	**0.0063**	**0.0000**
2	0.5714	**0.0878**	**0.0003**	0.2940	0.3391	**0.0102**	0.1074	**0.0038**
3	**0.0105**	**0.0007**	0.3393	0.2515	**0.0264**	0.7821	0.1283	**0.0014**
4	**0.0907**	**0.0003**	**0.0000**	0.1699	0.1269	**0.0919**	**0.0925**	**0.0005**
5	**0.0000**	**0.0000**	**0.0000**	0.3084	**0.0015**	**0.0107**	**0.0002**	**0.0000**
6	**0.0000**	**0.0001**	**0.0005**	**0.0000**	0.1439	**0.0266**	**0.0398**	**0.0000**
7	0.2538	0.3140	0.4211	0.4677	0.4677	0.1458	**0.0065**	**0.0148**
8	0.6054	**0.0000**	**0.0218**	0.2467	0.2033	0.2656	**0.0304**	**0.0000**

Table 5 The statistical test that should be selected to test the statistical significance of the *Level 1 gaps for each supplier-criterion combination*. The parametric t-test (t) is selected if both samples (supplier weights and buyer weights for this combination) follow normal distribution. The non-parametric Mann-Whitney test (M-W) is selected if one or both the samples do not follow normal distribution.

	A	B	C	D	E	F	G	H
1	M-W	M-W	M-W	M-W	M-W	M-W	M-W	M-W
2	t	M-W	M-W	M-W	t	M-W	t	M-W
3	M-W	M-W	M-W	M-W	M-W	M-W	M-W	M-W
4	M-W	M-W	M-W	M-W	t	M-W	M-W	M-W
5	M-W	M-W	M-W	M-W	M-W	M-W	M-W	M-W
6	M-W	M-W	M-W	M-W	M-W	M-W	M-W	M-W
7	t	t	t	M-W	t	t	M-W	M-W
8	M-W	M-W	M-W	t	t	t	M-W	M-W

Table 6 The results of the Shapiro-Wilk normality tests for the vectors in Tables 2-7. Under p=0.10, the vectors marked with * and the columns/rows whose names are written next to the matrices are *not* normally distributed (the Shapiro-Wilk p-value is less than the threshold p=0.10). Cells with $\sim N$ denote normally distributed vectors; empty cells indicate the irrelevancy of the test.

Vector/Matrix	**Normality Test Result**	**Vector/Matrix**	**Normality Test Result**
Average1 (Matrix)	Column F Rows 1, 3, 4, 5, 7, 8	Average11 (Matrix)	Column H Rows 2, 7

Appendix C. Level-2 Gaps

Table 7 Statistical significance of Level-2 gaps

Supplier Pair	A	B	C	D	E	F	G	H	Count of T
1-2	T	T	T	F	T	T	T	T	**7**
1-3	T	T	T	F	T	T	F	T	**6**
1-4	T	F	T	T	T	T	T	T	**7**
1-5	T	T	T	T	F	T	T	T	**7**
1-6	F	F	F	T	T	T	T	T	**5**
1-7	T	T	F	F	T	T	T	T	**6**
1-8	T	T	F	F	T	F	T	T	**5**
2-3	F	T	F	F	T	T	T	T	**5**
2-4	T	T	T	T	T	T	F	T	**7**
2-5	T	T	T	T	T	T	T	T	**8**
2-6	F	F	T	T	T	T	F	F	**4**
2-7	T	T	F	T	T	T	F	T	**6**
2-8	T	T	F	F	F	T	T	T	**5**
3-4	T	F	T	F	F	F	T	T	**4**
3-5	T	F	T	F	T	F	T	T	**5**
3-6	F	F	F	F	T	T	T	F	**3**
3-7	T	T	F	F	F	F	T	T	**4**
3-8	T	T	F	F	T	F	T	T	**5**
4-5	F	F	T	F	T	T	T	T	**5**
4-6	T	F	T	F	T	T	F	T	**5**
4-7	F	T	T	F	F	F	F	F	**2**
4-8	F	F	T	F	T	F	T	F	**3**
5-6	T	F	T	F	T	T	F	T	**5**
5-7	F	T	F	F	F	F	F	F	**1**
5-8	F	F	T	F	F	F	T	F	**2**
6-7	T	F	F	F	T	F	F	F	**2**
6-8	F	F	F	F	T	T	T	F	**3**
7-8	F	F	F	F	F	F	T	F	**1**
Count of T	**17**	**14**	**15**	**7**	**20**	**17**	**19**	**19**	**Total: 128**

Appendix D. Level-3 Gaps Analysis

Table 8 Statistical significance of Level-3 gaps

Organization	p
Within Supplier 1	0.0033
Within Supplier 2	0.8523
Within Supplier 3	0.0000
Within Supplier 4	0.0000
Within Supplier 5	0.0000
Within Supplier 6	0.0701
Within Supplier 7	0.0000
Within Supplier 8	0.0000
Within the Buyer for Supplier 1	0.0000
Within the Buyer for Supplier 2	0.0000
Within the Buyer for Supplier 3	0.0000
Within the Buyer for Supplier 4	0.0000
Within the Buyer for Supplier 5	0.0000
Within the Buyer for Supplier 6	0.0000
Within the Buyer for Supplier 7	0.0000
Within the Buyer for Supplier 8	0.0000

Appendix E. Machine learning model

Machine learning is the sub branch of artificial intelligence within computer science, concerned with the design and development of algorithms that allow computers to learn autonomously from empirical data, either supervised to model input-output relations, or unsupervised to model only input data (Alpaydın, 2009). The unsupervised machine learning methods employed in this study are distance maps, based on correlation, dendrograms that visualize the results of hierarchical clustering, and multi-dimensional scaling (MDS) graphs that visualize the proximity of a set of observations on a 2-D plane based on their similarities.

A machine learning model was constructed in the Orange data mining software for unsupervised learning (Figure 1). The unsupervised machine learning model aims at identifying subgroups of similar respondents and subsets of similarly *weighted* performance measures (questions). The model incorporates distance calculation based on Pearson correlation, distance map visualization superimposed with hierarchical clustering, and multi-dimensional scaling graph. Given the perceived *weights* for a given set of performance measures and for a group of respondents, the model initially computes the distances between the respondents. Then, distance map and the dendrogram are drawn based on the distance matrix. In Figure 2, the distances are computed based on Pearson correlation between perceived weight vectors for Supplier 1. Next, a multi-dimensional scaling is carried out, and the respondents are mapped with respect to each other (Figure 3).

Figures 2 and 3 help us to answer a fundamental question: Which respondents' *weights* are similar? Dendrogram (Figure 2) and MDS graph (Figure 3) both give us the proximity information, but in different ways: Dendrogram gives the proximity information in a hierarchical context, whereas MDS gives it in a geographical context. In the dendrogram (Figure 2), the respondents are connected under the same umbrella, such as respondent R108 and R104 and R112 and R116, whilst the MDS graph (Figure 3) represents the respondents that are close to each other in the map. The two mentioned pairs of respondents are close to each other in Figure 3, where the point (respondent) pairs that behave similarly (closes to each other) are linked by lines. In Figure 3, the colors of the points denote the roles of the respondents within that company. It shows that the Senior Managers are closer to each other, whereas the Front Line Staff is more dispersed in opinions.

The above analysis may have given us the clue to what can be done to close the Level-3 perception gap, and to achieve consistency throughout the company. One possible solution can be to first match the consistent individuals with each other to enable them to understand why they behave similarly, and then group them with the subgroups and individuals farthest from them. This way, the reasons for the largest gaps can be revealed through group meetings, and consistency can be improved.

Figures 2 and 3 can be drawn for a supplier not only based on the evaluation on the supplier side, but also based on the evaluations on the buyer side. Yet another analysis for each supplier could be the visualization of the respondents from the supplier and buyer combined. Such visualization would reveal not only Level-3 gaps, but also Level-2 gaps. Hence, regarding the weights of the criteria for each supplier, three dendrograms and three MDS graphs can be created, totaling to 48 graphs for the 8 suppliers. In this paper, the visualizations are given only for Supplier 1, based on the *weights* given at the supplier (Supplier 1). The same analysis was carried out based on the *weights* given by the respondents at the buyer and at both. These additional analyses are presented in the Appendices F and G of the supplement (Supplement).

It is evident that the analysis in Figures 2 and 3 can lead to identify the gaps between individuals for not only Level-3 analysis, but also for Level-1 and Level-2 analysis. For example, the combined analysis of the data for respondents for two suppliers through dendrogram and MDS graph can help in identifying the gaps at the much more detailed *individual* level, as opposed to the gaps at the company level.

Cross-communication is an indispensable part of remedy to close the gaps, and the machine learning techniques, as employed in the analysis, demonstrate how and where such communication can be improved.

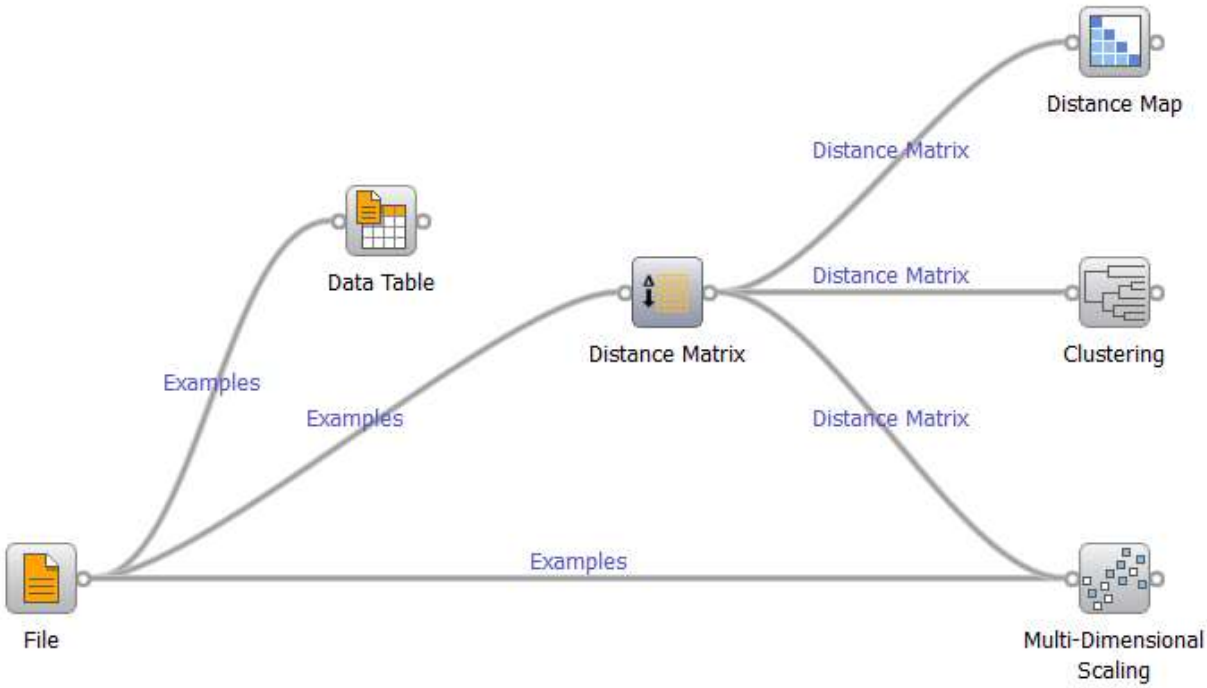

Figure 1 Unsupervised machine learning model for identifying subgroups of similar respondents and subsets of similarly weighted performance measures (questions). The model is constructed in the Orange data mining software.

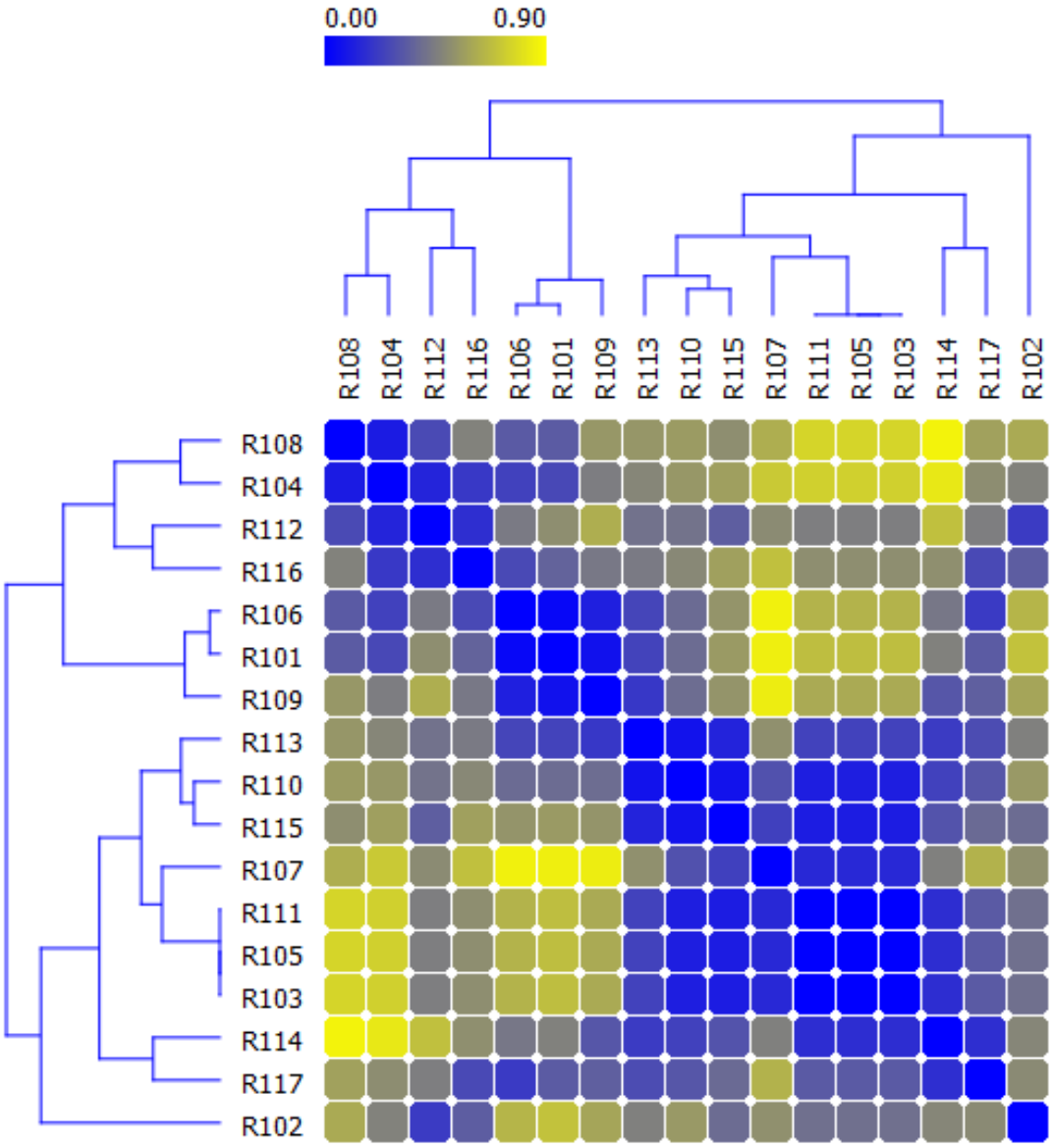

Figure 2 Dendrogram and distance map for the respondents (R101, …, R117) within Supplier 1

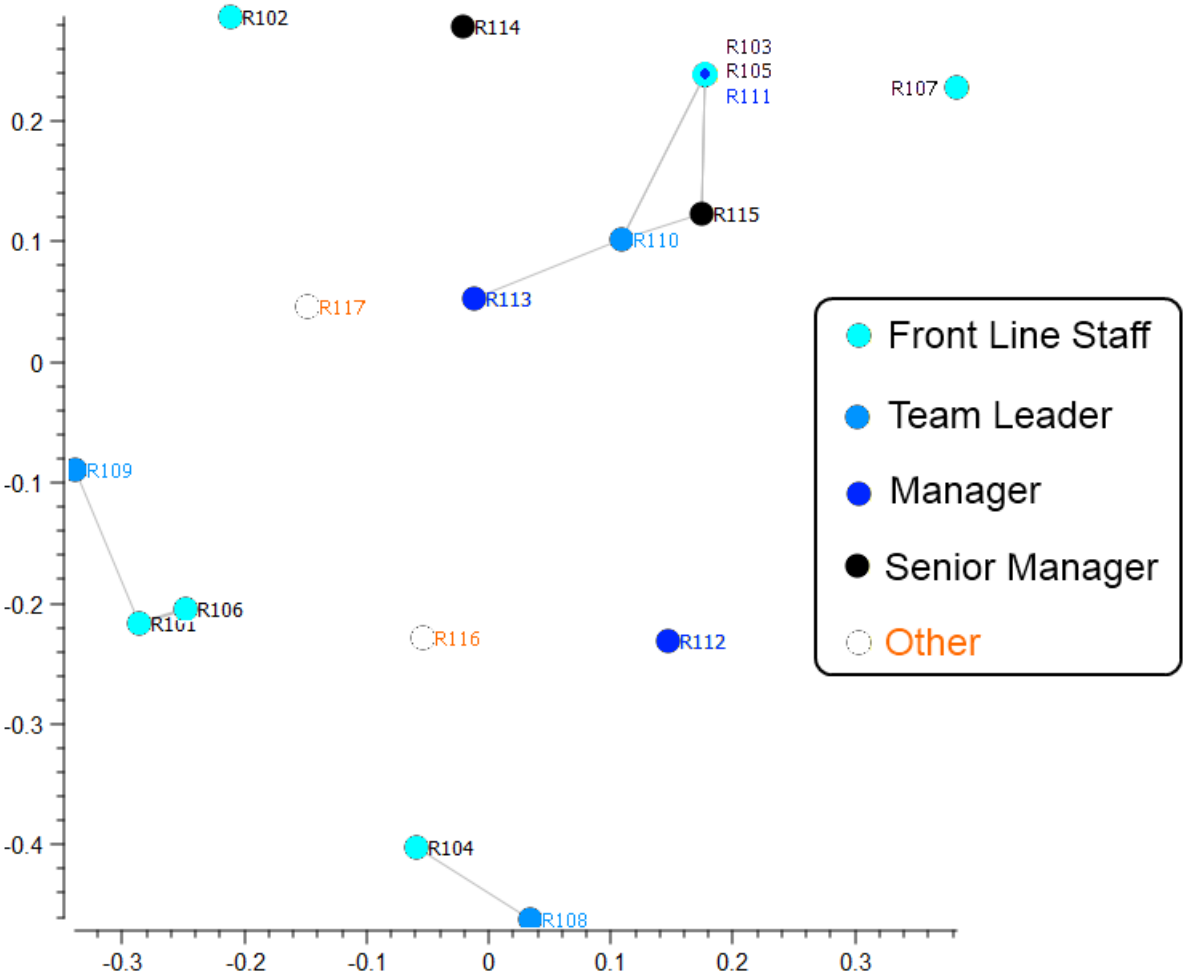

Figure 3 Multi-dimensional scaling (MDS) graph of the respondents at Supplier 1

Appendix F. Level-3 Gaps at the *buyer*, regarding the weights for Supplier 1

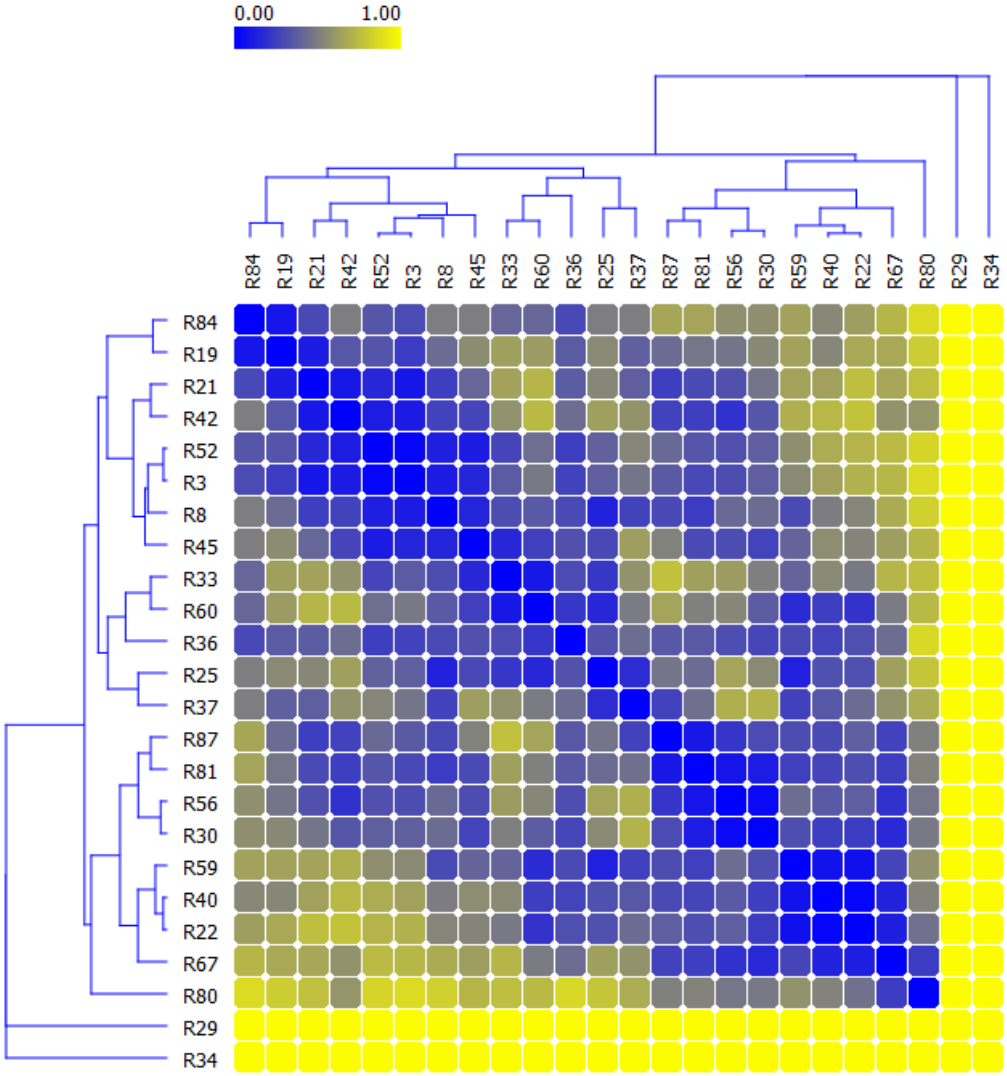

Figure 4 Dendrogram and distance map for the respondents at the *buyer* stage

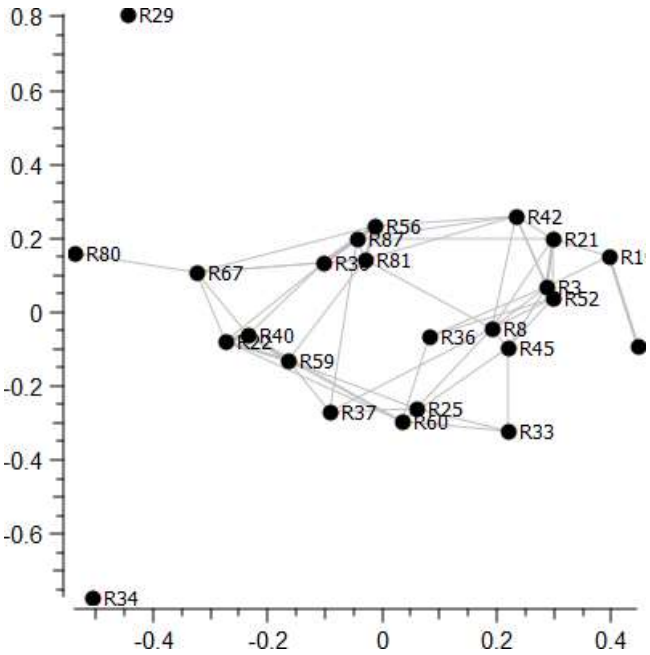

Figure 5 Multi-dimensional scaling graph (MDS) of the respondents at the *buyer* stage

Appendix G. Combined analysis of Level-1 and Level-3 Gaps, regarding the weights for Supplier 1

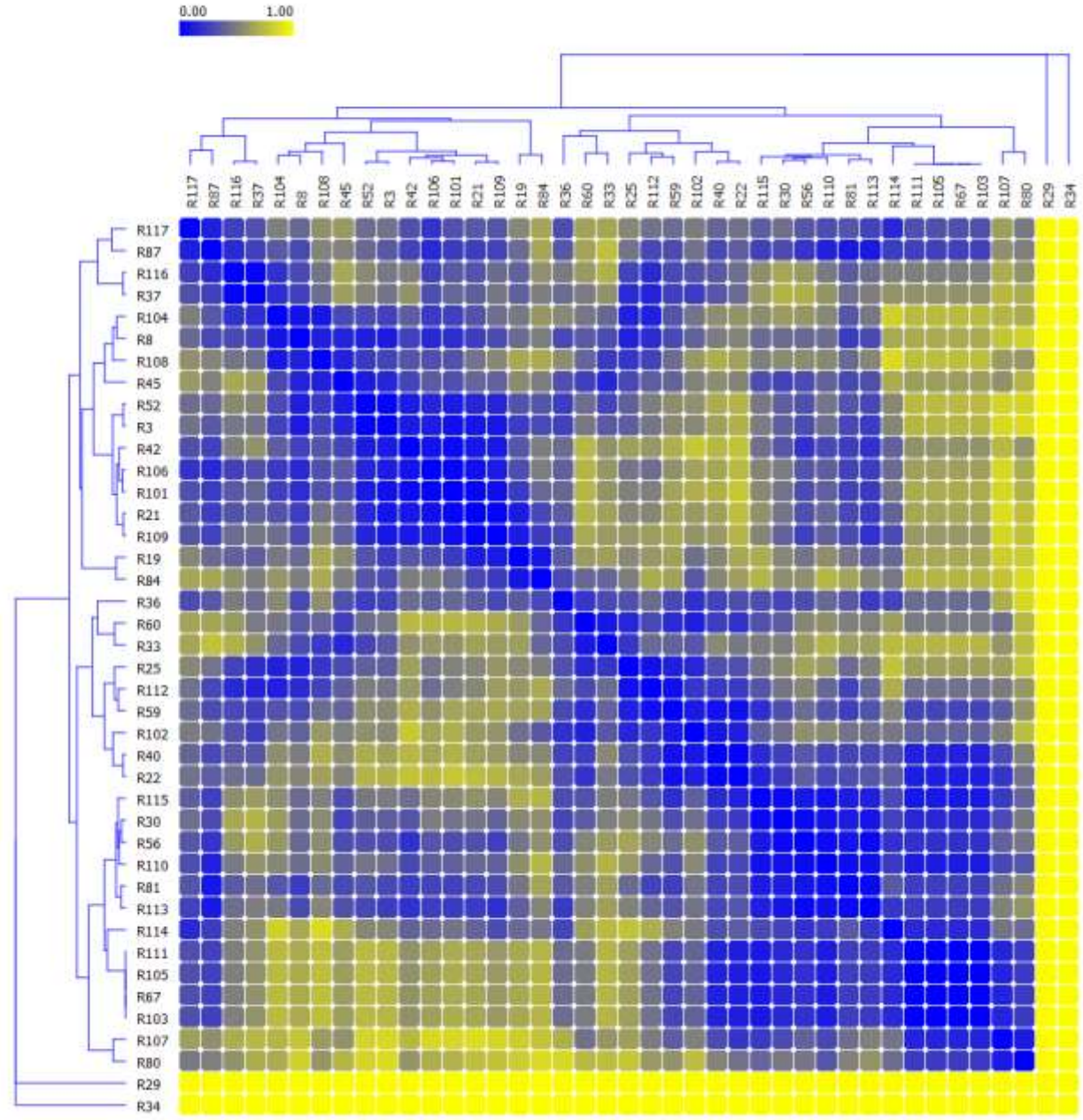

Figure 6 Dendrogram and distance map for the respondents at the *supplier and buyers* stages *combined*

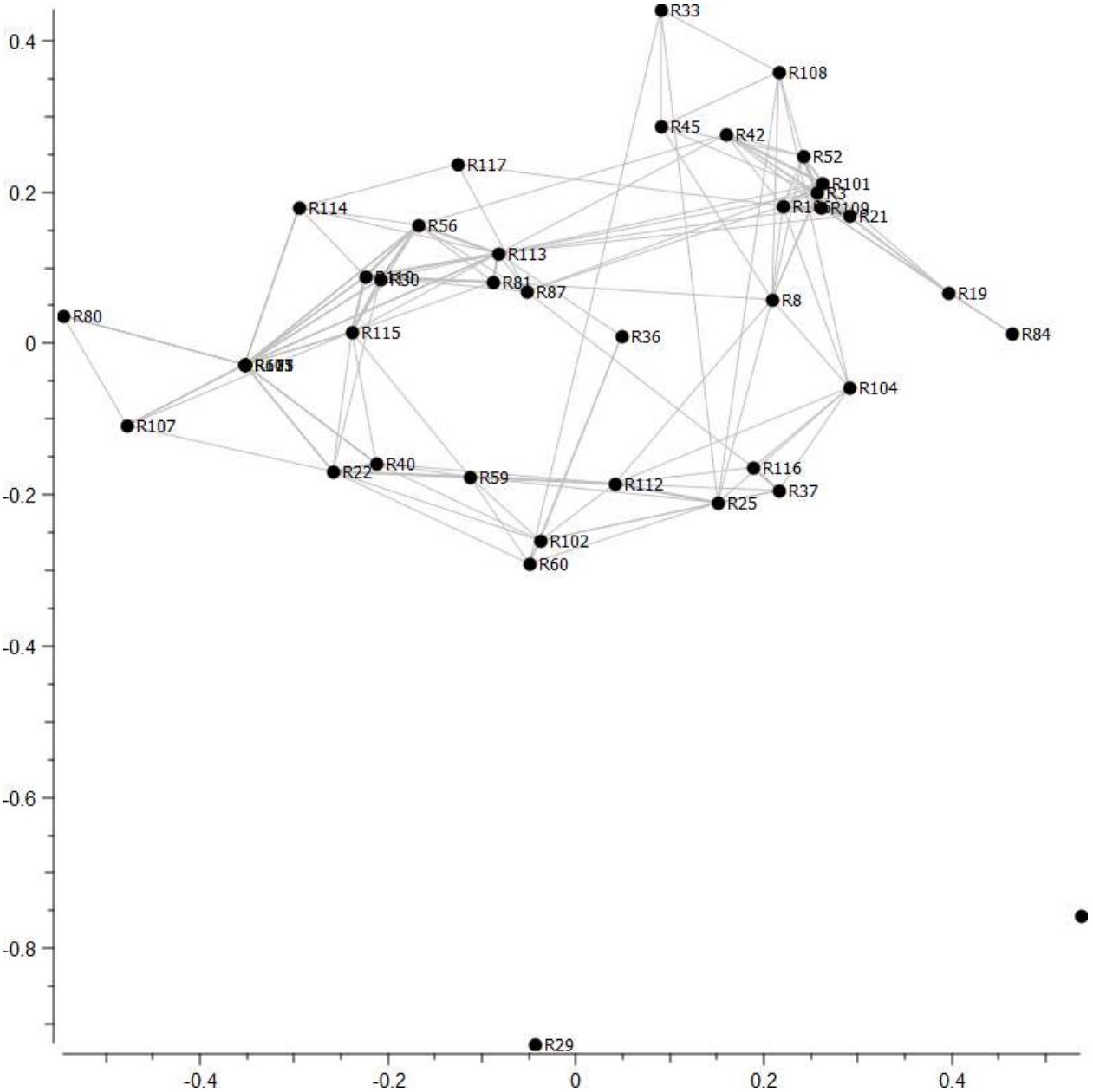

Figure 7 Multi-dimensional scaling graph (MDS) of the respondents at the *supplier and buyer* stages *combined*

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