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How Living Wages Influence Apparel Costs and Comparative Advantages among Different Multi-tier Supply Chains ⋆

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Abstract

This paper aims to reveal how paying manufacturing workers with living wages instead of minimum wages increases business costs and alters comparative advantages among 98 multi-tier supply chains, as well as to find the level of wage increase to make the lowest cost supply chain lose its competitiveness. Both scenario and sensitivity analyses are employed. The findings show that paying living wages neither significantly increases business costs nor influences comparative advantages of the 98 supply chains, implying no manufacturing relocation and unemployment. Furthermore, the findings present the importance of proximity between materials and product manufacturing locations. Lastly, governments can potentially create their location competitiveness supporting low transportation costs and port fees, and incentivizing materials manufacturing to attract other manufacturing activities.

Keywords: Global Value Chain; Manufacturing Location Decisions; Social Sustainability; Sustainable Sourcing; Sustainable Supply Network Design; Sweatshop Labour

1 Introduction

Sustainable Development Goals (SDGs) create awareness for organizations to tackle problems on poverty, climate change, and social and economic inequality. Sustainable development targets "building an inclusive, sustainable and resilient future for people and planet" [1]. Some businesses have made efforts to achieve SDGs by implementing corporate social responsibility programs, social compliance, environmental initiatives, and diversity and inclusion programs for employing

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and sourcing products from women, disabled individuals, minorities, veterans, and LGBT members. However, they have not fully achieved sustainability and inclusiveness in their supply chains because factory workers gain wages at a rate lower than the rise in living costs.

Few businesses succeed in paying living wages to their or their suppliers' factories [2]. Though the Living Wage Foundation website states there are 4,759 accredited living wage employers in United Kingdom (UK) from public, private, and voluntary sectors, the paid living wages are mostly to non-manufacturing workers in the UK. Manufacturing workers, especially in developing countries, still earn below living costs even though they perform adequately and work overtime in order to meet production demand [3]. The reason for ignoring payment of living wages to manufacturing workers could be from potentially increased costs, which could lead to decreased product demand [4] and negative effects on workers from the potential of manufacturing relocation, as shown in a discussion of sweatshop regulations to ensure certain working conditions and minimum wages [5]. However, a few existing studies on increasing wages for manufacturing workers show that increased costs from the living wage payments do not seriously affect businesses' bottom lines [6], and can be absorbed by increasing product prices because consumers, specifically in US, are willing to pay [7]. As a result, our research questions (RQs) are as follows:

RQ1. How much will living wages cost companies compared to minimum wages, in particular in labour-intensive industries? This will show possibilities for companies to manage the increased cost to help increase social sustainability at factories.

RQ2. Will the increased cost change comparative advantages among different multi-tier supply chains which consist of different materials and product manufacturing locations? This will show the potential of manufacturing relocation.

In this paper, we choose the textile and clothing industry as an example of a labour-intensive industry in order to show the influences of living wages on multi-tier supply chains. This paper differentiates itself from aforementioned studies by highlighting how various multi-tier supply chains are influenced by living wage payments with respect to increased costs and comparative advantage.

We firstly find increased garment landed costs from paying living wages instead of minimum wages to garment manufacturing workers. Landed costs include all incurred costs in order to get products delivered to warehouses. We model different supply chain scenarios by varying manufacturing locations of raw materials, in-process materials, and final products. Secondly, we investigate how living wages change manufacturing locations in the textile and clothing supply chain if the company objective is to minimize landed cost. Lastly, we perform sensitivity analysis to find which increased levels of living wages in developing countries will no longer yield cost advantage and may cause manufacturing movement to other countries. The results help both businesses and local governments recognize how to upgrade their products, and help countries to have other competitive advantages aside from low cost.

2 Background

2.1 Living Wages History and Current Implementation

The living wage concept can be tracked back to the 18th century, through Adam Smith's argument that labourers should receive fair payment [8]. In 1898, Samuel Gompers, the AFL president,

defined living wages as those "sufficient to maintain an average-sized family in a manner consistent with whatever the contemporary local civilization recognizes as indispensable to physical and mental health, or as required by the rational self -respect of human beings." [9]. Starting in 1919, living wages were recognized by the Constitution of the International Labour Organization, the United Nations Universal Declaration of Human Rights, the Council of Europe's European Social Charter, and the United Nations' International Covenant on Economic and Social Cultural Rights [8].

In the mid-1990's, about 140 cities in the United States of America (USA) passed living wage legislation and ordinance to pay living wages to employees of states, city contractors and sub-contractors, and businesses who gained financial support from states. Studies on living wage implementation show that the living wage ordinance created health improvement [10] and modest reduction of poverty [11, 12] in areas where they were passed. Clain [11] claimed that the living wage legislation did not cause unemployment because states who were customers were willing to bear the increased costs. In contrast, when compared to living wage legislation, minimum wage laws both resulted in higher prices to end consumers and did not reduce poverty. In contrast to Clain, an empirical study by Neumark & Adams [12] found that the living wage ordinance led to modest unemployment of low-skilled workers. Companies prefer to hire higher-skilled workers after increased wages [13].

In April 2016, the British government passed a law mandating a National Living Wage for workers aged 25 years and older. However, the National Living Wage was not based on real living costs [14]; moreover, some employers managed their increased costs by cutting employee benefits, working hours, and overtime [15]. These actions did not meet the right to a living wage that "... should be earned in a standard working week (no more than 48 hours) and allow a garment worker to be able to buy food for herself and her family, pay the rent, pay for healthcare, clothing, transportation and education and have a small amount of savings for when something unexpected happens." [16]. Furthermore, due to differences in family sizes and living costs in each city, living wage calculations would have to be based on the cost of living in each area. Some organizations that performed such calculations include Glasmeier & the Massachusetts Institute of Technology (USA) [17], the Living Wage foundation (UK) [14], The Asian Floor Wage Alliance (Asia) [18], and WageIndicator Foundation (55 countries) [19].

Specifically, for living wages in the textile and clothing industry, some organizations such as The Fair Wear Foundation showed solutions online about how clothing brand companies could implement living wage payments to manufacturing workers. Nevertheless, only four out of 50 surveyed clothing companies started to increase wages, and even their efforts were not enough to reach living wage payment [20]. OXFAM Australia [21] also shows the living wage payment progress of 23 clothing companies in four steps from supplier transparency, making commitment, publishing plan, to paying living wages. Only 11 companies showed supplier transparency and none reached the other additional steps towards paying living wages [21].

2.2 Wages and Manufacturing Locations Decisions

Though living wages for manufacturing workers have not been widely recognized and implemented, in the textile and clothing industries there are numerous organizations, such as Clean Clothes Campaign, the Asia Floor Wage Alliance, and OXFAM Australia, urging clothing companies to pay living wages for manufacturing workers. Moreover, the government of Bangladesh, which

is one of the biggest garment manufacturers in the world, has implemented minimum wages for textile and clothing workers [22]. As a result, clothing brand companies have started to pay attention to living wages and have plans to increase manufacturing worker wages for social compliance. However, many companies overlook the living wage issue when making manufacturing location decisions. In this paper, manufacturing location decisions refer to the locational decisions of either selecting suppliers for sourcing materials and products (known as outsourcing manufacturing), or locating their own factories (known as in-house manufacturing).

Factors influencing manufacturing decisions mainly involve resource availability, logistics and industrial infrastructure, and total costs of manufacturing and doing business [23, 24]. Moreover, participants in Tate et al. [24] were more concerned with labour costs, as well as the stability of labour and transportation costs, in the three years following the survey, rather than at the time of the survey. Living wages directly impact not only labour costs, but also the stability of labour costs, because if wage payments at manufacturing locations have not reached the living wage level, there is a high possibility that labour costs will be increased so that businesses practices will align with social compliances to pay living wages to workers. Therefore, to ensuring long-term supply and manufacturing location planning to avoid future increased costs and switching costs, it is necessary for businesses to consider whether materials suppliers and product manufacturers have paid living wages to their workers.

2.3 Textile and Clothing Supply Chain and the System Boundary

The textile and clothing supply chain has to be understood first in order to investigate different possible locations of raw materials, in-process materials, and product manufacturing, as well as to calculate landed cost. The textile and clothing supply chain consists of fibre, yarns, fabrics, and garment manufacturing stages, as well as transportation between the stages and to the warehouse for customers as shown in Fig. 1.

Fig. 1 shows the system boundary of this paper for investigating how living wages affect total landed cost per unit for textile and clothing manufacturing location decisions. Incurred costs in fibre manufacturing processes are not included in this paper's calculations because the costs are already reflected in the purchasing price of fibres. The cost calculations start from buying and transporting fibres from a fibre manufacturer to a yarn and fabric manufacturer, then extend to yarn and fabric processing, transporting fabrics to a garment manufacturer, garment processing, and finally, transporting garments to a warehouse. Costs involving distributing garments to customers, sales, recycling, and functions at the headquarter are not included in the calculations because the costs should be the same in every scenario and we are interested in landed cost.

3 Methods

We use scenario and sensitivity analyses to investigate the influences of living wages on manufacturing locations in each supply chain stage. Scenario methods help to better understand the causality of events and to challenge and change conventional mindsets [25]. Moreover, scenario techniques are widely used in various research fields, including leadership, environment, agriculture, risk, retail, migration, climate change, urban planning, and strategic planning, and are considered research methodology that can produce interesting, usable, and rigorous research [26].

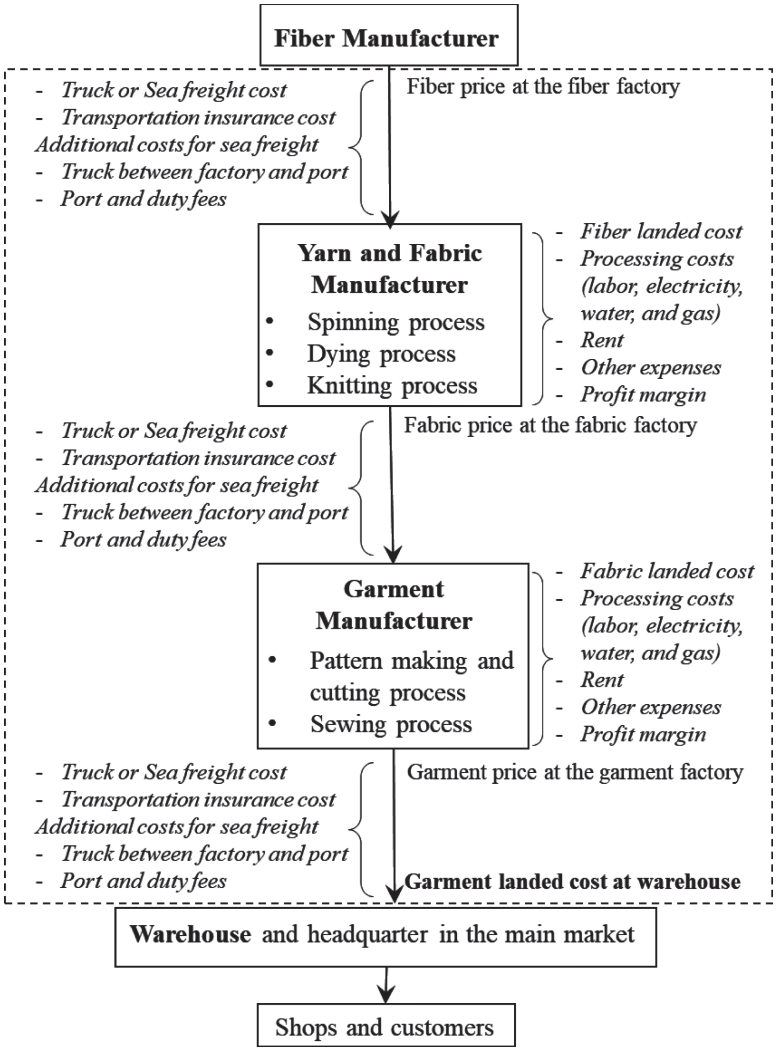


Fig. 1: Textile and clothing supply chain: involved factors and system boundary in the dashed line rectangle

Scenario analysis allows us to calculate and compare per-unit landed cost at an assigned warehouse in each supply chain scenario. Each supply chain scenario has different configuration of manufacturing locations for raw materials, materials, and final products. We also compare the landed cost of each scenario between using minimum wages and using living wages. After getting the supply chain scenario that provides the lowest landed cost, a "local" sensitivity analysis helps explore how much wages can increase until it no longer provides the lowest landed cost. We use the local sensitivity analysis technique because this paper aims to learn how wages as an input influence the target outcome, the landed cost, as local sensitivity analysis helps investigate the relationship between the output and one input by keeping other input variables constant [27].

The calculations of per-unit landed costs of all scenarios with minimum wages, living wages, and different degrees of increased living wages were done in Microsoft Excel. The following sections present how we sampled manufacturing and warehouse locations, calculated per-unit landed cost, and conducted scenario and sensitivity analysis. The information regarding input data for the calculations are available upon requests.

3.1 Manufacturing and Market Locations

To ensure the most consistent quality of raw materials in the different scenarios, we choose viscose materials whose staple fibres can be produced in both Europe (Austria) and Asia (China) by the same company. Next, we assumed that fabrics and garments are manufactured in the same cities as the fibre manufacturers and the market. We later added different cities in Europe, China, and Bangladesh for fabric and garment manufacturing locations. The cities are selected according to their distances to the market and fibre production locations, the availability of manufacturers, and different living costs in order to provide different scenarios. We chose Germany as the final market to locate warehouses and headquarters because it had the highest value of apparel market among other European countries in 2017, and has been forecasted to maintain the same rank to 2022 [28]. Fig. 2 shows the location options at each supply chain stage and the market. In total, there are 98 supply chain scenarios from configuring the supply chain scenarios with two possible fibre manufacturing locations, seven possible fabric manufacturing locations, and seven possible garment manufacturing locations. The numbers 1 to 7 in Fig. 2 represent each manufacturing city and are used for expressing the locations of fibre, fabric, and garment manufacturing in this format: fibre manufacturing location - fabric manufacturing location - garment manufacturing location. For example, 2-2-2 SC refers to Nanjing-Nanjing-Nanjing Supply Chain.

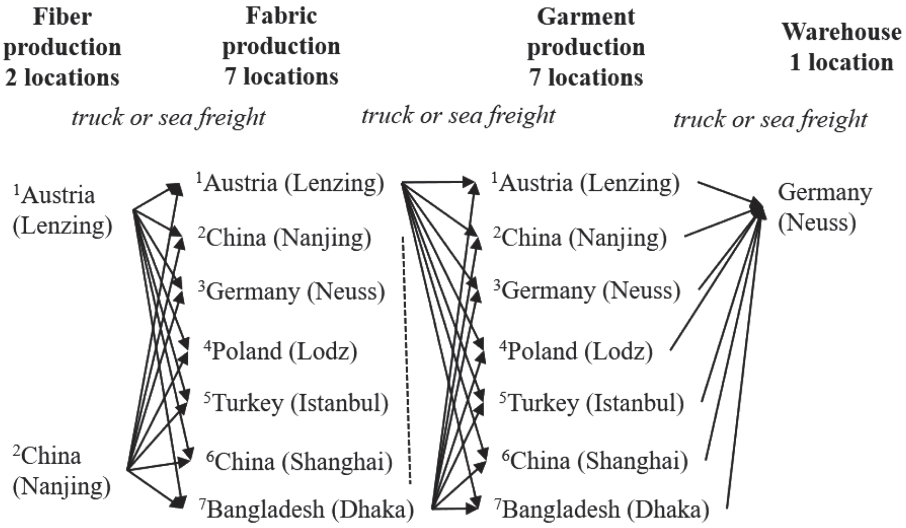


Fig. 2: Textile and clothing supply chain: involved factors and system boundary in the dashed line rectangle

3.2 Per-unit Landed Cost Calculation

The initial assumption for the calculation is a one-time purchase of 1,800 t-shirts made of viscose fabric. The goal is to find where to source fibres and produce fabrics and garments in order to get the lowest per-unit landed cost at the warehouse in Germany. Wages in different countries and increased wages when applying living wages influence per-unit landed costs through the operation minutes performed by employees in fabric and garment production processes. We adopt the total landed cost concept because we focus on product-related purchase in a supply chain [29]. It is important to consider not only product cost but also costs incurred after production, such as transportation costs and import duties [30]. The per-unit landed cost at the warehouse comprises

accumulated costs from fibre to garment manufacturing stages of supply chain shown in Fig. 1. We consider all direct material inputs, processing and operation costs, including utilities and rent, other expenses and profits for fabric and garment manufacturers, door-to-door transportation costs (including transport insurance costs), custom clearance and port fees for sea freight shipping, and import duties. We did not consider non-measurable costs or costs for controlling or dealing with unanticipated risks in the supply chain, such as quality, performance, and exchange rate [31], as this paper focuses on investigating the effect on manufacturing locations from varying wages involved in measurable cost calculation, rather than value and risk calculation. Therefore, the calculation in every stage uses Eq. (1), Eq. (2), listed below, to find the per-unit landed cost at the warehouse.

$$\begin{aligned}&\text{Landed cost} = \\ &\quad \text{EXW price} + C_{T(\text{toport})} + C_{P(\text{origin})} + C_F + C_I + C_D + C_{P(\text{destination})} + C_{T(\text{fromport})},\end{aligned} \tag{1}$$

where C_T is truck cost between port and origin and destination; C_P is port fees; C_F is freight costs by truck or sea; C_I is transportation insurance cost; C_D is import duty.

$$\text{EXW price} = C_{\text{Input}} + C_L + C_E + C_W + C_G + C_R + C_O + P, \tag{2}$$

where EXW price is the purchasing price of orders at the fibre, fabric, or garment factory; C_{Input} is landed cost of input; C_L is labour cost; C_E is electricity cost; C_W is water cost; C_G is gas cost; C_R is rental cost; C_O is other expenses; and P is profit margin of manufacturer.

In addition to the system boundary, Fig. 1 shows relevant costs in each supply chain stage. The cost calculation starts from the EXW price of fibres, which is the purchase price at a fibre factory, and excludes transportation costs from the factory to a destination. The landed cost of fibre, which is the input for yarn and fabric manufacturing, consists of the EXW fibre price, fibre transportation costs, transportation insurance, and duty and port fees if applicable. The landed cost of input fibre together with other manufacturing costs of yarns and fabrics result in the EXW price of fabrics. The other manufacturing costs are calculated from operation minutes performed by employees; consumptions of electricity, water and gas for producing required amount of fabrics for the garment manufacturing; rental costs; other expenses, assumed to be 10 percent; and profit margin of the manufacturer, assumed to be 10 percent. The 10 percent is an average value from observations on how manufacturers calculate their costs and quoted prices to customers. Moreover, when using 5 and 20 percent instead of the 10 percent, the lowest and highest cost scenarios of both minimum and living wages do not vary, implying that the percentages of other expenses and profit margins do not affect comparative advantage of the scenarios; only their landed costs change.

After that, the landed cost of fabrics as the input material for garment manufacturing is calculated from the combination of the EXW price of fabrics, fabric transportation costs, transportation insurance, and duty and port fees, if applicable. The landed cost of fabrics together with other manufacturing costs of garments results in the EXW price of garments. The elements for calculating other manufacturing costs of garments are similar to the ones in the yarns and fabrics manufacturing stage. Finally, the per-unit landed cost of garments at warehouse are calculated from the total costs of the EXW garment price, garment transportation costs, transportation insurance, and duty and port fees if applicable divided by the total number of t-shirts.

3.3 Scenario and Sensitivity Analysis

All costs stated in the Per-unit Landed Cost Calculation section were calculated in individual cells of Microsoft Excel. This allowed us to check whether the indexed value to other Excel sheets for consumption and costs rates were correct. It also allowed us to see which factors have high or low costs in each scenario as well as to compare different costs among different scenarios. There are three rounds of calculations shown in Fig. 3 for using minimum wages, living wages, and varied living wages of the lowest landed cost scenario as the variable input influencing labour costs and finally landed costs.

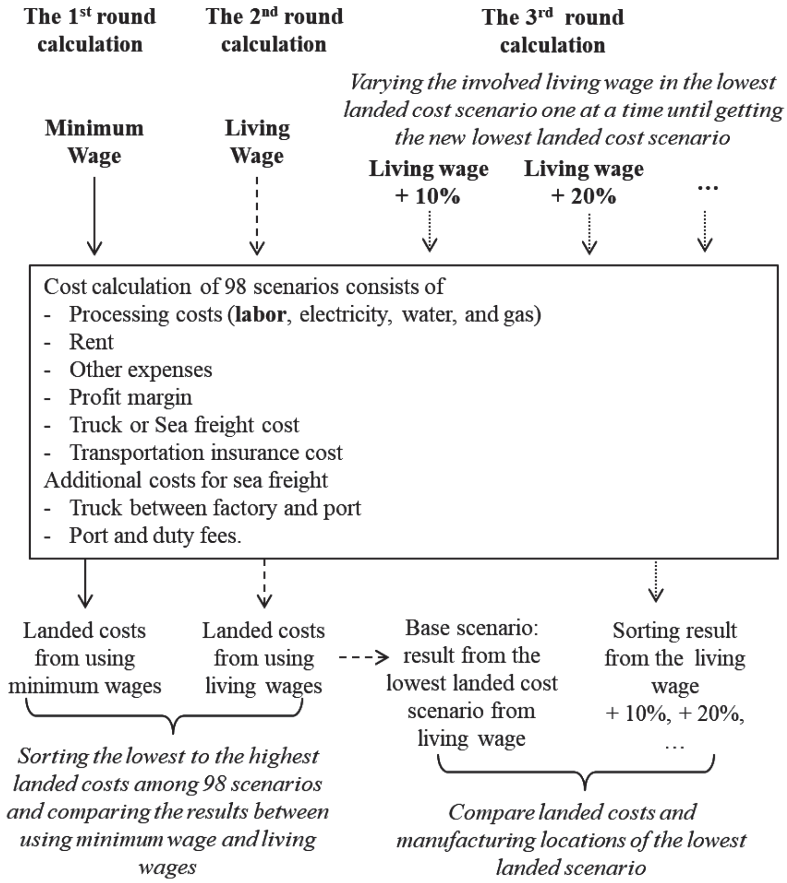


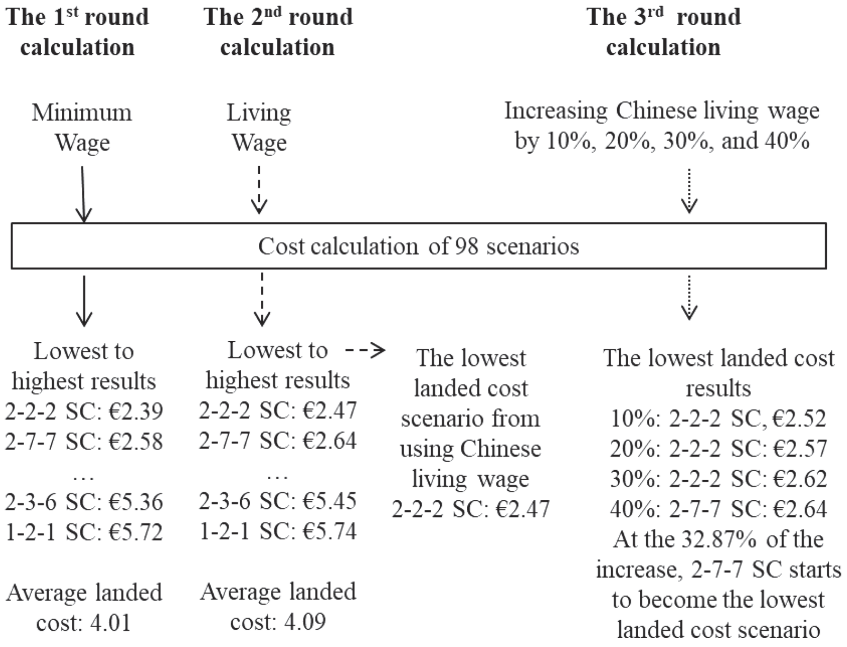
Fig. 3: Method steps for scenario and sensitivity analysis and calculation

The first round of calculation and analysis uses minimum wages as the input wage. The results of all 98 scenarios are sorted by ranking the per-unit landed costs from the lowest to the highest value. The second-round calculation uses living wages as the input wage. The other parameters remain the same as the first round. After getting landed costs of all 98 scenarios and ranking them, we compare the resulting living wages with minimum wages to see how much the landed costs are affected by the increased input wage and whether manufacturing locations in each stage of the supply chain have changed. Moreover, we investigate the manufacturing locations along the supply chain and incurred costs along the supply chain in order to know how labour costs and other costs contribute to the landed cost. The third round of calculation and analysis involves varying only the living wage(s) of the manufacturing locations in the lowest landed cost scenario resulting from the second round of calculation. The living wage at each location is varied one at a time with an increase of 10% until the configuration of manufacturing location is changed.

The results are compared with the second-round results, which is the base scenario of using living wages in order to see at what percentage of increased wages causes manufacturing relocation.

4 Results and Discussions

The overviews of results from the three rounds of calculations are shown in Fig. 4. Fig. 4 shows examples of the lowest to the highest landed cost scenarios among the 98 scenarios when using minimum and living wages. It also shows the sensitive analysis results, presenting the increased percentage of living wages that cause manufacturing relocation. The detailed discussions of the 1^{st} and 2^{nd} round calculations are in Subsection 4.1, while the 3^{rd} round calculation is in Subsection 4.2.



Remarks: number – number – number SC stands for fiber manufacturing location – fabric manufacturing location – garment manufacturing location in supply chain. The location numbers are referred from Table 1: 1 = Lenzing, Austria; 2 = Nanjing, China; 3 = Nuess, Germany; 4 = Lodz, Poland; 5 = Istanbul, Turkey; 6 = Shanghai, China; 7 = Dhaka, Bangladesh.

Fig. 4: Results from scenario and sensitivity analysis and calculation

4.1 The Effects of Minimum Wage and Living Wage on Manufacturing Locations

Garment landed costs are calculated with minimum wages and living wages in all 98 scenarios. Both minimum wages and living wages give similar results in terms of ranked supply chain (SC) scenarios, the lowest and highest landed costs, and average value and standard deviation of landed costs per piece shown in Table 1. The results imply that comparative advantages among different multi-tier supply chains barely vary after changing from minimum to living wages.

Table 1: Per-unit landed costs of each supply chain (SC) scenario: comparison between using minimum and living wages in calculations

Scenario ranking of per-unit landed costs	Per-unit landed costs using minimum wages	Per-unit landed costs using living wages	Percentage of cost increase of the same SC
1st (lowest)	2-2-2 SC: €2.39	2-2-2 SC: €2.47	3.49
2nd	2-7-7 SC: €2.58	2-7-7 SC: €2.64	2.28
3rd	1-7-7 SC: €2.66	1-7-7 SC: €2.72	2.21
4th	1-5-5 SC: €2.70	1-5-5 SC: €2.82	4.42
5th	1-4-4 SC: €2.89	2-2-7 SC: €2.96	
6th	2-2-7 SC: €2.89	1-4-4 SC: €2.97	
7th	1-4-5 SC: €2.90	1-4-5 SC: €3.00	3.81
8th	1-5-4 SC: €2.95	1-5-4 SC: €3.05	3.11
9th	2-6-7 SC: €3.01	2-6-7 SC: €3.07	1.99
10th	2-2-5 SC: €3.06	1-5-7 SC: €3.16	
...			
89th	2-1-1 SC: €4.92	2-3-1 SC: €4.93	
90th	2-4-2 SC: €5.06	2-4-2 SC: €5.15	1.71
91st	1-2-3 SC: €5.09	2-4-6 SC: €5.18	
92nd	2-4-6 SC: €5.11	1-2-3 SC: €5.22	
93rd	1-6-1 SC: €5.26	1-6-1 SC: €5.28	0.29
94th	2-1-2 SC: €5.30	2-1-2 SC: €5.36	1.20
95th	2-3-2 SC: €5.31	2-1-6 SC: €5.40	
96th	2-1-6 SC: €5.35	2-3-2 SC: €5.42	
97th	2-3-6 SC: €5.36	2-3-6 SC: €5.45	1.77
98th (highest)	1-2-1 SC: €5.72	1-2-1 SC: €5.74	0.32
Average value	4.01	4.09	2.00
Standard deviation	0.72	0.71	

Remarks: number – number – number SC stands for fibre manufacturing location – fabric manufacturing location – garment manufacturing location in supply chain. Location numbers are as follows: 1 = Lenzing, Austria; 2 = Nanjing, China; 3 = Neuss, Germany; 4 = Lodz, Poland; 5 = Istanbul, Turkey; 6 = Shanghai, China; 7 = Dhaka, Bangladesh.

The results in Table 1 show that manufacturing fibres, fabrics, and garments in Nanjing, China and later shipping the final products to Germany (2-2-2 SC) give the lowest landed cost. Surprisingly, Bangladesh and Turkey, whose minimum wages are much lower than those of Nanjing, China, do not give the lowest landed cost. This is because the savings from lower Bangladeshi labour wages are lower than the increased costs of shipping fibres from China to Bangladesh (2-7-7 SC), which include inland and international transportation, as well as expensive port fees in Bangladesh. This finding shows that low labour costs alone cannot make a manufacturing location be attractive and competitive, as labour costs are only a portion of the total landed

cost including the total cost of doing business. Therefore, it is necessary to ensure that other costs in doing the business are competitive or inexpensive besides low labour costs when making manufacturing decision [24].

When shipping less than a full container load, the size of the shipment determines transportation costs and port fees. Garment shipment sizes are smaller than fibre shipments, which are smaller than fabric shipments. Therefore, in order to achieve the low landed costs, shipping garment (2-2-2 SC) is preferable to shipping fibres (2-7-7 SC) which is preferable to shipping fabrics (2-2-7 SC) shown in Table 1. Our findings point out expensive inland transportation costs in China can be overcome by choosing the right stage of supply chain to transport raw materials, materials, or final products according to the size of shipment. The concept of saving transportation costs by transporting small shipments incurred in any supply chain stages can be applied to other industries. If an industry has final products which are heavier, larger, and more difficult to move than raw materials, the products are normally produced near customers [24].

Moreover, the five lowest landed cost scenarios with minimum wages show that manufacturing fabrics and garments at the same locations resulted in the low landed costs. Additionally, sourcing both inexpensive and expensive fibres from locations near the low-cost fabrics and garments manufacturing locations results in a low landed cost. For example, though stapler fibres manufactured in Austria are expensive, they can yield low landed costs if fabrics and garments are manufactured in proximity to low-cost countries such as Bangladesh, Turkey, and Poland.

In order to see how businesses will get affected by increasing wages from implementing living wages, including whether businesses can pay for the extra costs but still sustain their businesses [32], we compared, in all 98 scenarios, the landed costs of minimum wages with living wages. The change in average value of per-unit landed costs when using living wages instead of minimum wages is 2%. 4.42% from 1-5-5 SC is the highest increased percentage of per-unit landed costs after applying living wage. The lowest increase percentage is 0.29% from 1-6-1 SC. The findings reveal that implementing living wages increases the landed costs only slightly, even though the living wages are much higher than the minimum wages as a percentage. Furthermore, though Bangladesh living wages have the highest increase percentage from minimum wage, the landed costs of Bangladeshi manufacturing scenarios do not increase much compared to the increased landed costs of Turkish and Polish manufacturing scenarios. This is because labour costs are only a small portion of the landed costs structure in low-wage countries. Our findings confirm Gray et al. [31]'s statement that rising labour costs in Asia, including other factors such as exchange rates and rising energy costs, did not make total landed costs increase enough to lead to reshoring decisions of moving foreign manufacturing back to the home country. Therefore, the results suggest that paying living wages does not create manufacturing movement and unemployment [33].

4.2 The Effect of Increased Chinese Living Wages on Manufacturing Locations

After knowing that manufacturing fibres, fabrics, and garments at the same location in Nanjing, China is the lowest landed cost scenario (2-2-2 SC), we investigate how much increased Chinese wages will affect Chinese manufacturing landed cost. We increased the original living wage of China by increments of 10%. The results in Table 2 show that increasing the wage by 10% does not affect the ranking of manufacturing locations. However, increased wages make the total landed cost higher when fabric and garment manufacturing is located in China. Increased wages affect

more garment manufacturing than fabric manufacturing due to higher required labour operation minutes for garment manufacturing. Increasing the wage by 20% influences the ranking of landed cost scenarios. The landed cost of manufacturing fabrics and garments in Poland with Austrian fibres (1-4-4 SC) becomes lower than the landed cost of manufacturing garments in Bangladesh with Chinese fabrics made of Chinese origin fibres (2-2-7 SC). After increasing the Chinese living wage by 40%, manufacturing fibres, fabrics, and garments at the same location in Nanjing, China (2-2-2 SC) is no longer been the lowest landed cost scenario. Shipping Chinese fibres in order to manufacture fabrics and garments in Bangladesh (2-7-7 SC) becomes the lowest landed cost scenario since the Chinese living wage is increased by 32.87%.

The findings show that there is still room for Chinese wages to be increased until the location is not competitive in terms of landed cost. However, if Chinese wages increase 10%-15% every year, China will not be competitive in terms of lowest landed cost within 3-4 years. Therefore, if businesses want to have long term cooperation with suppliers in order to avoid switching costs, businesses have to check current wage levels in the targeted manufacturing city, whether the wage covers the living costs of workers, and whether there is a trend of increasing wages. Besides the wage level, productivities and performance of workers are also important in saving costs by using less operations minutes and avoiding defects. Other anticipated problems and risks due to distance and governance are also relevant, though they are not associated in per-unit landed cost calculation [31]. Therefore, businesses may consider other manufacturing locations which do not provide the lowest landed costs but which offer better governance and risk avoidance.

Table 2: Changes in per-unit landed costs and scenario ranking when increasing chinese living wages at different levels

Scenario ranking of per-unit landed costs	Used Chinese living wage	The living wage + 10%	The living wage + 20%	The living wage + 30%	The living wage + 40%	The living wage + 32.87%
1^{st} (lowest)	2-2-2 SC: €2.47	2-2-2 SC: €2.52	2-2-2 SC: €2.57	2-2-2 SC: €2.62	2-7-7 SC: €2.64	2-7-7 SC: €2.64
2^{nd}	2-7-7 SC: €2.64	2-7-7 SC: €2.64	2-7-7 SC: €2.64	2-7-7 SC: €2.64	2-2-2 SC: €2.67	2-2-2 SC: €2.64
3^{rd}	1-7-7 SC: €2.72	1-7-7 SC: €2.72	1-7-7 SC: €2.72	1-7-7 SC: €2.72	1-7-7 SC: €2.72	1-7-7 SC: €2.72
4^{th}	1-5-5 SC: €2.82	1-5-5 SC: €2.82	1-5-5 SC: €2.82	1-5-5 SC: €2.82	1-5-5 SC: €2.82	1-5-5 SC: €2.82
5^{th}	2-2-7 SC: €2.96	2-2-7 SC: €2.97	1-4-4 SC: €2.97	1-4-4 SC: €2.97	1-4-4 SC: €2.97	1-4-4 SC: €2.97
6^{th}	1-4-4 SC: €2.97	1-4-4 SC: €2.97	2-2-7 SC: €2.98	2-2-7 SC: €2.99	2-2-7 SC: €3.00	2-2-7 SC: €2.99

Remarks: number – number – number SC stands for fibre manufacturing location – fabric manufacturing location – garment manufacturing location in supply chain. The location numbers are as follows: 1 = Lenzing, Austria; 2 = Nanjing, China; 3 = Neuss, Germany; 4 = Lodz, Poland; 5 = Istanbul, Turkey; 6 = Shanghai, China; 7 = Dhaka, Bangladesh. Bolded text identifies scenarios in which manufacturing relocations have occurred after increased living wages.

5 Conclusion

This paper shows how increased wages can influence manufacturing locations in a supply chain by using the example of the textile and clothing supply chain. All 98 scenarios of minimum wage calculation and 98 scenarios of living wage calculation are compared. The findings show that paying living wages instead of minimum wages does not significantly affect the final landed costs of garments arriving at a German warehouse and the landed cost ranking of manufacturing

location scenarios. The latter implies that increased costs from living wage payment do not change comparative advantages among different multi-tier supply chains. Furthermore, businesses applying living wages will pay extra per-unit landed costs at the maximum of 4.42% from minimum wages. The average of increased landed cost to businesses is 2%, in exchange for significantly helping workers and their families gain decent lives from living wages. The findings also suggest that paying living wages does not seem to create unemployment and manufacturing location movement.

Surprisingly, manufacturing fibre, fabrics, and garments in Nanjing, China is the lowest landed cost scenario for both minimum wage and living wage calculation, even though wages in Bangladesh and Turkey are much lower. Increasing wages to living costs in certain locations does not make garment landed costs significantly higher than paying minimum wages, as labour costs are only a small portion of the total cost of doing business to produce a garment; transportation and port fees are more significant. For the textile and clothing industry, fabric shipment size affects transportation costs and port fees. Therefore, it is more economical to ship fibres than to ship fabrics to nearby low-cost countries in order to manufacture fabrics and garments in the same location. Furthermore, the results from using both minimum and living wages for calculations show that the proximity between raw materials, in-process materials, and product manufacturers were the primary determinants of the five lowest landed cost scenarios. The higher the degree of vertical manufacturing where raw materials, in-process materials, and final products are manufactured in the same or nearby locations is, the lower landed cost is. Our findings imply that governments can create competitiveness for their cities as manufacturing locations by supporting low transportation costs and port fees. Moreover, a country or a region can be competitive when there is a raw material manufacturing located in the country or region. Governments can also attract manufacturing industries for which raw materials are more voluminous than the final products (such as in the textile and clothing industries) by supporting raw materials manufacturing in order to attract other manufacturing activities, such as in-process materials and product manufacturing.

Our paper only considers per-unit landed costs without performance costs, anticipated problems and risks, and environmental costs. Therefore, future research and businesses may add other aspects to the calculations in order to find favourable manufacturing locations in a supply chain. Some locations in this paper may not be low-cost locations if governance, performance, and environmental costs are considering. However, future research needs to construct how to measure the governance, performance, and environmental costs as well as how to combine them into the per-unit landed costs or to incorporate in manufacturing location decisions.

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