

3 Proof of Theorem 4

In this section, we give a proof of Theorem 4. We denote by $P[u, v]$ a path connecting two vertices u and v , which are the end-vertices of P . For a vertex set X of a graph G , let $\langle X \rangle_G$ denote the subgraph of G induced by X .

Proof of Theorem 4. If G has a hamiltonian path, we are done, and so we may assume that G does not have a hamiltonian path. Let P be a longest path in G , and let u and v be the end-vertices of P . We assign an orientation in P from u to v , and for a vertex x of P , we denote its successor and predecessor, if any, by x^+ and x^- , respectively. The following claim holds immediately by the fact that P is a longest path of G .

- Claim 1.** (i) $N_G(u) \cup N_G(v) \subseteq V(P)$.
(ii) G has no cycle C with $V(C) = V(P)$.
(iii) $N_G(u)^- \cap N_G(v) = \emptyset$ and $\{v\} \cup N_G(u)^- \cup N_G(v) \subseteq V(P)$.

By Claim 1, we have

$$\begin{aligned} |V(P)| &\geq |N_G(u)^-| + |N_G(v)| + |\{v\}| = \deg_G(u) + \deg_G(v) + 1 \\ &\geq \sigma_2(G) + 1 \geq |G| - k + 2. \end{aligned} \tag{1}$$

Hence $|G| - |V(P)| \leq k - 2$. Since G is a connected graph, by connecting all the vertices in $V(G) - V(P)$ to P by edges or paths, we can obtain a spanning tree T of G with at most k leaves.

Next, we prove that T is a caterpillar. Otherwise, there exists a vertex $w \in V(G) - V(P)$ such that $N_G(w) \cap V(P) = \emptyset$. By the choice of w and by Claim 1, the following claim easily holds.

- Claim 2.** (i) $\{w, u, v\}$ is an independent set of G .
(ii) $N_G(w) \subseteq V(G) - V(P) - \{w\}$.

By Claim 2 (i), we have

$$\deg_G(w) + \deg_G(u) + \deg_G(v) \geq \frac{3\sigma_2(G)}{2} \geq \frac{3}{2}(|G| - k + 1). \tag{2}$$

On the other hand, it follows from Claim 2 (ii) and Claim 1 that

$$\begin{aligned} &\deg_G(w) + \deg_G(u) + \deg_G(v) \\ &= |N_G(w)| + |N_G(u)^-| + |N_G(v)| \\ &\leq |G| - |P| - 1 + |P| - 1 = |G| - 2. \end{aligned} \tag{3}$$

By (2) and (3), we have $|G| \leq 3k - 7$. Hence, the theorem holds when $|G| \geq 3k - 6$.
Next we consider the case where $|G| = 3k - 7$. In this case, $\sigma_2(G) \geq |G| - k + 1 = 2k - 6$. Furthermore, if $k \leq 4$, then $|G| \leq 5$ and so the theorem holds. Hence we may assume that $k \geq 5$.

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Hence $|G| - |V(P)| \leq k - 2$. Since G is a connected graph, by connecting all the vertices in $V(G) - V(P)$ to P by edges or paths, we can obtain a spanning tree T of G with at most k leaves.

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2019 年年度报告

单位：元 币种：人民币

项目	本期发生额	上期发生额
其他应收款坏账损失	-8,597,541.41	
债权投资减值损失		
其他债权投资减值损失		
长期应收款坏账损失		
合同资产减值损失		
应收账款坏账损失	-19,646,002.94	
合计	-28,243,544.35	

其他说明：
无

72、资产减值损失

√适用 □不适用

单位：元 币种：人民币

项目	本期发生额	上期发生额
一、坏账损失		19,927,925.82
二、存货跌价损失及合同履约成本减值损失	-25,053,664.86	-49,558,472.85
三、可供出售金融资产减值损失		-1,161,704.60
四、持有至到期投资减值损失		
五、长期股权投资减值损失		
六、投资性房地产减值损失		
七、固定资产减值损失	-2,623,595.64	
八、工程物资减值损失		
九、在建工程减值损失	-717,000.00	-3,594,100.00
十、生产性生物资产减值损失		
十一、油气资产减值损失		
十二、无形资产减值损失		
十三、商誉减值损失		-1,064,725.15
十四、其他		
合计	-28,394,260.50	-35,451,076.78

其他说明：
无

73、资产处置收益

√适用 □不适用

单位：元 币种：人民币

项目	本期发生额	上期发生额
固定资产处置利得	1,330,236.69	1,117,762.98
固定资产处置损失	-1,486,227.17	
合计	-155,990.48	1,117,762.98

其他说明：
无

74、营业外收入

营业外收入情况

√适用 □不适用

单位：元 币种：人民币

项目	本期发生额	上期发生额	计入当期非经常性损益
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项目	本期发生额	单位：元 币种：人民币
其他应收款坏账损失	-8,597,541.41	
债权投资减值损失		
其他债权投资减值损失		
长期应收款坏账损失		
合同资产减值损失		
应收账款坏账损失	-19,646,002.94	
合计	-28,243,544.35	

其他说明：
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√适用 □不适用

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一、坏账损失		19,927,925.82
二、存货跌价损失及合同履约成本减值损失	-25,053,664.86	-49,558,472.85
三、可供出售金融资产减值损失		-1,161,704.60
四、持有至到期投资减值损失		
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七、固定资产减值损失	-2,623,595.64	
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十、生产性生物资产减值损失		
十一、油气资产减值损失		
十二、无形资产减值损失		
十三、商誉减值损失		-1,064,725.15
十四、其他		
合计	-28,394,260.50	-35,451,076.78

其他说明：
无

73、资产处置收益

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营业外收入情况

√适用 □不适用

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项目	本期发生额	上期发生额	计入当期非经常性损益
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